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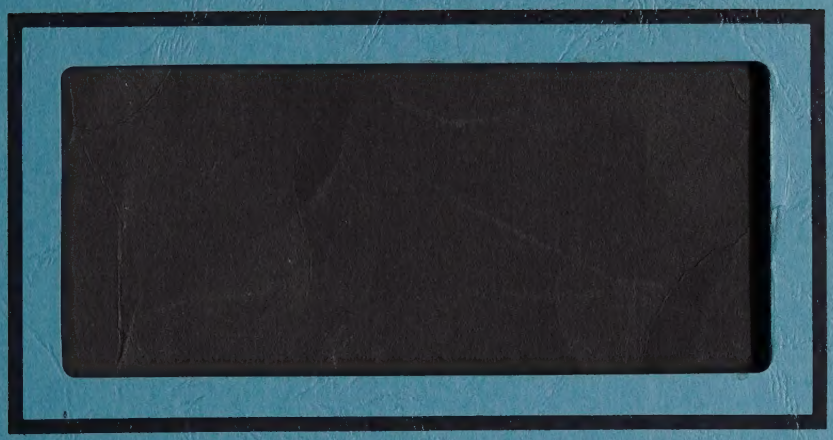

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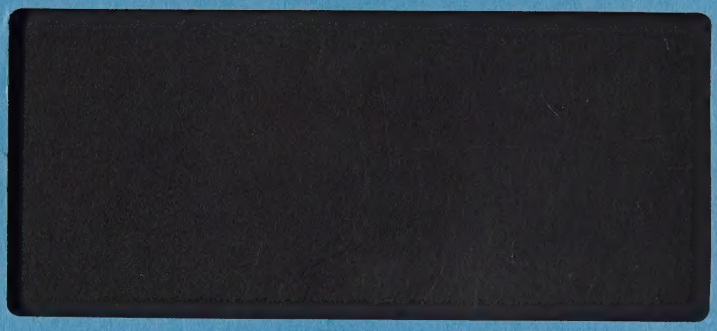

INSTRUCTION MANUAL

MODEL 7030

VCF GENERATOR

s/n 5814 and below

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EXACT® electronics, inc.
Box 160 Hillsboro, Oregon
97123 Tel. (503) 648-6661
TWX 910-460-8811
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SECTION I

SPECIFICATIONS

AND

VERIFICATION OF SPECIFICATIONS PROCEDURE

VERIFICATION OF SPECIFICATIONS

It is recommended that the instrument be operated with covers in place for a period of 1 hr. before verification of specifications.

The following test equipment or suitable equivalents of known accuracy are required for complete specification validation

Oscilloscope, DC to 90MHz
Differential Input with 5mv/cm sensitivity
Tektronix 7704 with 7A13 Plug-in or equivalent
Counter-Timer, 50MHz to 10,000 seconds
Hewlett Packard 5326B or equivalent
DVM, .01% accuracy with 1,000 meg ohm floating input
Fairchild 7000 or equivalent
Harmonic Distortion Analyzer, less than .1% residual distortion
Hewlett-Packard 333 or equivalent
Spectrum Analyzer, 1MHz to 300MHz
Nelson Ross PSA 311 in Tektronix 544 frame or equivalent

Preset all the front panel controls as follows:

MULTIPLIER - 1.0
RANGE - 1K
SYMMETRY - mid range
FUNCTION - square
AMPLITUDE - mid range
D.C.OFFSET - mid range
ATTENUATOR - all sections deactivated
VARIABLE SYMMETRY - deactivated

FREQUENCY ACCURACY: To measure the frequency accurately all frequency measurements below 1 kilohertz are expressed in period time and all above in hertz. With the counter connected to main output:

Mult. | Range	Actual Setting	Accuracy	Generator should be within
1.0 X .01	.01Hz	±(2% of setting + 2% of Range)	104 Sec. to 96 Sec.
.10 X .01	.001Hz	"	1220 " to 780 "
1.0 X .1	.1Hz	±(1% of setting + 1% of Range)	10.2 " to 9.8 "
.10 X .1	.01Hz	"	111 " to 89 "
1.0 X 1	1.0Hz	"	1.02 " to .98 "
.10 X 1	.10Hz	"	11.1 " to 8.90 "
1.0 X 10	10Hz	"	.102 " to .098 "
.10 X 10	1.0Hz	"	1.11 " to .890 "
1.0 X 100	100Hz	"	10.2ms to 9.80 ms
.10 X 100	10Hz	"	111 ms to 89.0 ms
1.0 X 1K	1KHz	"	1.02 ms to .980 ms
.10 X 1K	100Hz	"	11.1 ms to 8.90 ms
1.0 X 10K	10KHz	"	9.80KHz to 10.2KHz
.10 X 10K	1KHz	"	.890KHz to 1.11KHz
1.0 X 100K	100KHz	"	98.0KHz to 102KHz
.10 X 100K	10KHz	"	8.90KHz to 11.1KHz
1.0 X 1M	1.0MHz	"	.980MHz to 1.02MHz
.10 X 1M	100KHz	"	89.0KHz to 111KHz
1.0 X 10M	10MHz	±(2% of Range + 2% of setting)	9.60MHz to 10.4MHz
.10 X 10M	1MHz	"	.780MHz to 1.22MHz

SINE DISTORTION: Return the Function Selector to Sine Wave and also check to see that generator frequency is set for 1 kilohertz. Amplitude Control should be set for mid range.

1. Connect Distortion Analyzer to the Output Connector terminated into 50Ω. Measure the sine distortion of less than .5% typically .2%.

2. Set the Range to 100K. Measure Sine distortion of less than .5%.

3. Set Range to 10MHz. Connect the Spectrum Analyzer to main output jack and measure the harmonic content. Observe no harmonics less than 30 db down.

SINE FREQUENCY RESPONSE: Set the Range to 10K and connect the oscilloscope to the Output connector.

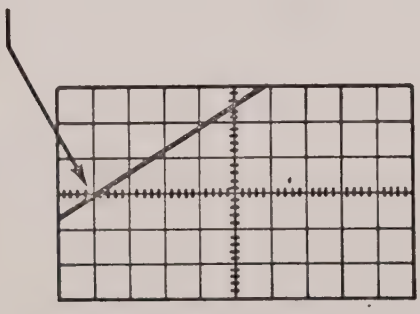
1. Observe sine wave amplitude.
2. Set Range to 100K. Observe sine amplitude drop less than .1 db.
3. Set Range to 10MHz. Observe sine amplitude drop less than 2 db.

SQUARE WAVEFORM: Set Function Switch to Square. Set Amplitude Control for an output voltage of 10V peak to peak or less into 50Ω. Any voltage greater than this value could yeild a rise time that is slower due to the slewing rate limitations.

1. Observe the rise and fall time to be less than or equal to 20 nanoseconds.
2. Observe that the overshoot and ringing are less than 5% of maximum peak to peak amplitude.

TRIANGLE LINEARITY: Set Range Switch to 1K. Set the Function Selector to Triangle. Monitor the Output Connector with the oscilloscope.

1. Adjust the oscilloscope to obtain 1/2 cycle of the triangular waveform across the full horizontal grid on the oscilloscope CRT.
2. Reset the Differential Plug-in to a sensitivity of 20 millivolts per centimeter.
3. Adjust the comparison voltage until the slope of the triangle waveform intersects the mid-scale horizontal grid line at the second major mark as shown below.



TRIANGLE LINEARITY: (Continued)

4. Record reference voltage using the DVM accurate to I millivolt.

5. Adjust the comparison voltage until slope of triangle intersects next major horizontal grid mark.

6. Record accurately the new reference voltage.

7. Repeat to obtain as many points as desired.

8. Calculate linearity and observe linearity is within specifications.

9. Beware of oscilloscope inadequacies above 10KHz.

FREQUENCY STABILITY: Connect Frequency Counter to main output terminated into 50Ω. Measure frequency accurately. Note the frequency reading. Wait 10 minutes. Measure frequency again and note that frequency change should be less than .05%. Wait 24 hrs. Measure frequency again and note reading remains within .25%.

AMPLITUDE STABILITY: Set amplitude control to maximum. Set DC Offset to Off. Function to Triangle. Connect output of generator to oscilloscope and measure the output, both positive and negative peaks with a 20 millivolt per centimeter sensitivity on the oscilloscope. Measure accurately and record the value of the positive and negative peaks that the triangle produced at the output. Wait 10 minutes and measure positive and negative peaks again and observe the amplitude changes less than 15 millivolts. Wait 24 hrs., measure the positive and negative peaks again and observe the amplitude change is less than 75 millivolts. Note that when measuring the amplitude using the peaks the maximum peak to peak value is the addition of the two peak values.

TIME SYMMETRY: Connect the counter timer to the Sync Output Connector on the front panel. Set the Range to 10K and set the Multiplier to 1.0. Set the Counter Timer to read time interval A to B and B to A. Observe the time symmetry error is less than 1%.

1. Set Range switch to 1K. Observe time symmetry error less than 1%.

2. Set Range to 100. Observe time symmetry error less than 1%.

3. Set Range to 10. Observe time symmetry error less than 1%.

4. Set Range to 1. Observe time symmetry error less than 1%.

SECTION 2

OPERATING INSTRUCTIONS

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

1. Power On/Off Switch - turns on input power to instrument.

2. Pilot Lamp - indicates input power is On.

3. Function selector - selects waveform to appear at Output connector.

4. Amplitude Control - Allows 20 db continuously variable voltage at Output conector.

5. D.C. Offset - Allows continuously variable D.C. level of waveforms at the Output connector when activated by Offset Variable 7.

6. Sync Out - Provides square waveform for synchronizing other equipment to Sine Square Triangle or Pulse waveforms.

7. Offset Variable - Activates the Variable D.C. offset control.

8. Offset Fixed - Selects unipolar waveforms at the Output connector. Activating this control maintains the most negative excursion of the waveform at zero volts (within instrument tolerance) and allows continuously variable control of the amplitude. (For Sine Square Triangle only).

9. Offset Negative - When activated at the same time as Offset Fixed reverses the action so that the most positive excursion is at zero volts (within tolerance) (Note 8 and 9 above for Offset Variable deactivated).

10. Attenuator 10 db, 20 db, 30 db - Allows fixed step attenuation of waveforms appearing at the Output connector. Any combination of the three controls can be activated providing a maximum additive step attenuation of 60 db.

11. Output connector - Provides 50 ohm output impedance for waveforms selected by the function selector.

2.1.0 FRONT PANEL FAMILIARITY (Figure 2.1.1)

12. Multiplier - Provides calibrated fixed steps between range settings. Each step equals 10% of range. The S position places the generator in the search mode of operation. The inner dial allows variable adjustment of frequency between the fixed steps of the outer multiplier dial.

13. Range Switch - Selects the desired frequency range.

14. Symmetry - Provides a continuously variable control of generator time symmetry. This Control operates over a range of 19 to 1 while reducing the normal generator frequency to approximately 1/10th indicated frequency.

15. External Offset - Provides an input for externally injecting DC offset of the waveform provided at the output connector. This input provides a one to one inverting relationship to the output connector.

16. Variable Symmetry - Activates the continuously variable Symmetry.

17. VCF In - Provides for externally controlling generator frequency by application of DC or AC voltages.

18. Sync In - Accepts an external input signal for frequency synchronization.

2.2.0 REAR PANEL FAMILIARITY (Figure 2.2.0)

1. Line Voltage Selector - Allows instrument operation at 117 or 220 volts AC.
2. Fuse Holder - Allows easy replacement in the event of fuse failure.
3. Line Cord - Accepts input power for the instrument.
4. Circuit Common Connection - Allows floating circuit common operation of instrument.
5. Chassis Ground Connection - Provides for grounding of circuit commons.
6. Power Transistor - Minus 15 volt supply Q175.
7. Power Transistor - Plus 15 volt supply Q135.
8. Power Transistor - Plus 24 volt supply Q125.
9. Power Transistor - Minus 24 volt supply Q145.

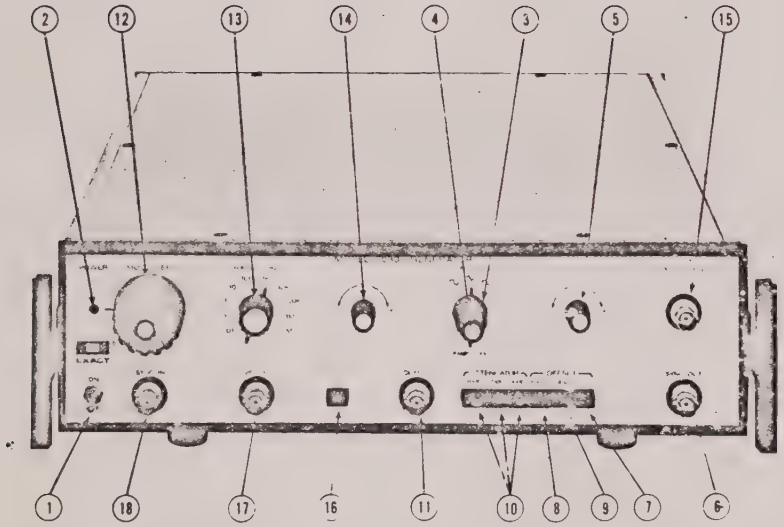


FIGURE 2.1.1 MODEL 7030
FRONT PANEL FAMILIARITY (A)

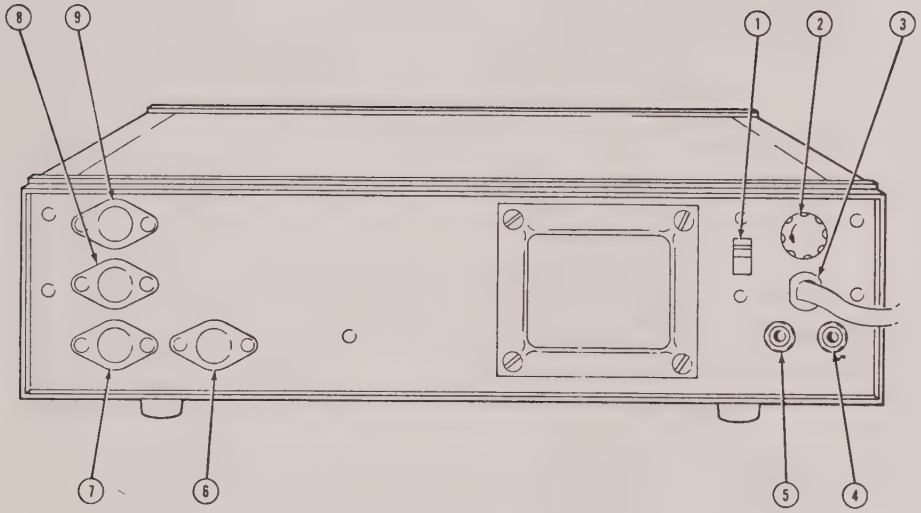


FIGURE 2.2.0 REAR PANEL FAMILIARITY (A) (D)

2.3.0 FIRST TIME OPERATION

NOTE: Before applying power to the instrument the input power line switch must be in the proper position corresponding to the line voltage source which will be applied. The instrument is supplied with the proper fuse for 117 volt operation. If the unit is to be operated from 220 volts AC, place the line switch located on the rear panel to the 220 volt position and change the fuse as indicated by the fuse data silk screened on the rear panel.

NOTE: It is recommended that the rear panel chassis ground and circuit ground connections be connected together with the grounding strap provided unless it is necessary to float the instrument ground.

1. Plug the instrument into source of 117 volt 50 to 400 cycle AC power and turn on Power switch. Preset all front panel controls as follows:

MULTIPLIER	to 1.0
RANGE	to 1K
SYMMETRY	to mid range
FUNCTION	to Triangle
DC OFFSET	to mid range
VARIABLE SYMMETRY	deactivated (out)
ATTENUATOR	deactivated (all three buttons out)
OFFSET	deactivated (all three buttons out)
AMPLITUDE	Maximum clockwise

2.3.0 FIRST TIME OPERATION

2. WAVEFORMS
   Connect generator outputs throught 50Ω coaxial cable into 50Ω coaxial load and the vertical input of a suitable oscilloscope. The instrument should be providing a 1 kilohertz triangular waveform at approximately 15 volts peak to peak amplitude.
3. FUNCTION
   Switch the function selector through its Sine, Triangle and Square waveforms and observe the change in wave shape on the oscilloscope. Return the function selector to Sine wave.
4. AMPLITUDE
   Rotate the amplitude control through its range and note that there is a continuously variable control of 20db on the output amplitude of the generator. Return this amplitude control to mid range.
5. FIXED OFFSET
   Depress the fixed offset button and note that the waveform reduces in amplitude on the oscilloscope presentation and also note that its most negative excursion is 0 volts. Again rotate the amplitude control through its range and note that the most negative excursion under any condition is 0 volts for the selected waveform. Next depress the negative offset button while leaving the fixed offset button depressed. Note that the waveforms most positive excursion now is 0 volts and as you rotate the variable amplitude control this condition remains the same. Note that both fixed and negative offset buttons must be depressed to activate this mode. Deactivate both the fixed and negative offset buttons and return the variable amplitude control to mid range.
6. VARIABLE OFFSET
   Depress the variable offset button and rotate the DC offset control and note that the DC level of the waveform is now adjustable. Note maximum output signal levels must not be exceeded when utilizing both maximum amplitude and any amount of DC offset. Deactivate the variable offset button and return the amplitude control to mid range.
7. EXTERNAL OFFSET
   Using a low impedance variable voltage source apply a small voltage to the external offset input and note that for each positive volt of input there is a matching negative volt of output from the generator. Again noting that maximum output cannot exceed the maximum output level of the generator. Also note that for each negative volt of external offset applied there is a positive volt on the output thus verifying the relationship as a 1 to 1 inverting configuration. Remove the external supply and return the variable amplitude control to maximum clockwise.
8. ATTENUATOR
   Depress the 10db attenuator and note that the output amplitude reduces to approximately 1/3 of its original level. Deactivate the 10db attenuator and then depress the 20db attenuator and note that the output amplitude drops to approximately 1/10th its original level. Deactivate the 20db attenuator and depress the 30db attenuator and note that the output amplitude is reduced to approximately 1/30th the original amplitude. Leaving the 30db attenuator activated depress the 10db attenuator and note that the overall attenuation then adds to be 40db and so forth and so on until a maximum of 60db attenuation is attainable through the push button attenuation. Note also that these attenuators attenuate the DC offset in the same porportion as the output amplitude. Return all attenuator buttons to a deactivated state.

2.3.0 FIRST TIME OPERATION

9. VARIABLE SYMMETRY

Depress the variable symmetry button and note that the generator frequency reduces to approximately 1/10th the original frequency. Rotate the variable symmetry control and note that the time symmetry of the waveform can be shifted from a 19 to 1 and then 1 to 19 ratio. This control may best be utilized in the triangle or square function and in these cases either a ramp/negative ramp or a pulse/negative pulse is produced Deactivate the variable symmetry control and return the function selector to sine wave.

10. EXTERNAL SYNC

Connect an external oscillator signal of approximately 5 volts peak to peak and approximately 1 kilohertz in frequency to the sync input connector. Rotate the multiplier dial until the generator frequency is within 1% of the applied synchronizing frequency and the two generators should phase lock or synchronize together. This can be demonstrated by connecting the external synchronizing input of the oscilloscope to the external 1 kilohertz synchronizing source. As the waveform generator then becomes synchronized with the external source the waveform as it appears on the oscilloscope will not move and will be reasonably stable Disconnect the external synchronizing signal and connect the oscilloscope external synchronizing input to the waveform generator sync output connector Note that the oscilloscope again can be synchronized using the sync out connector.

11. MULTIPLIER AND FREQUENCY RANGES

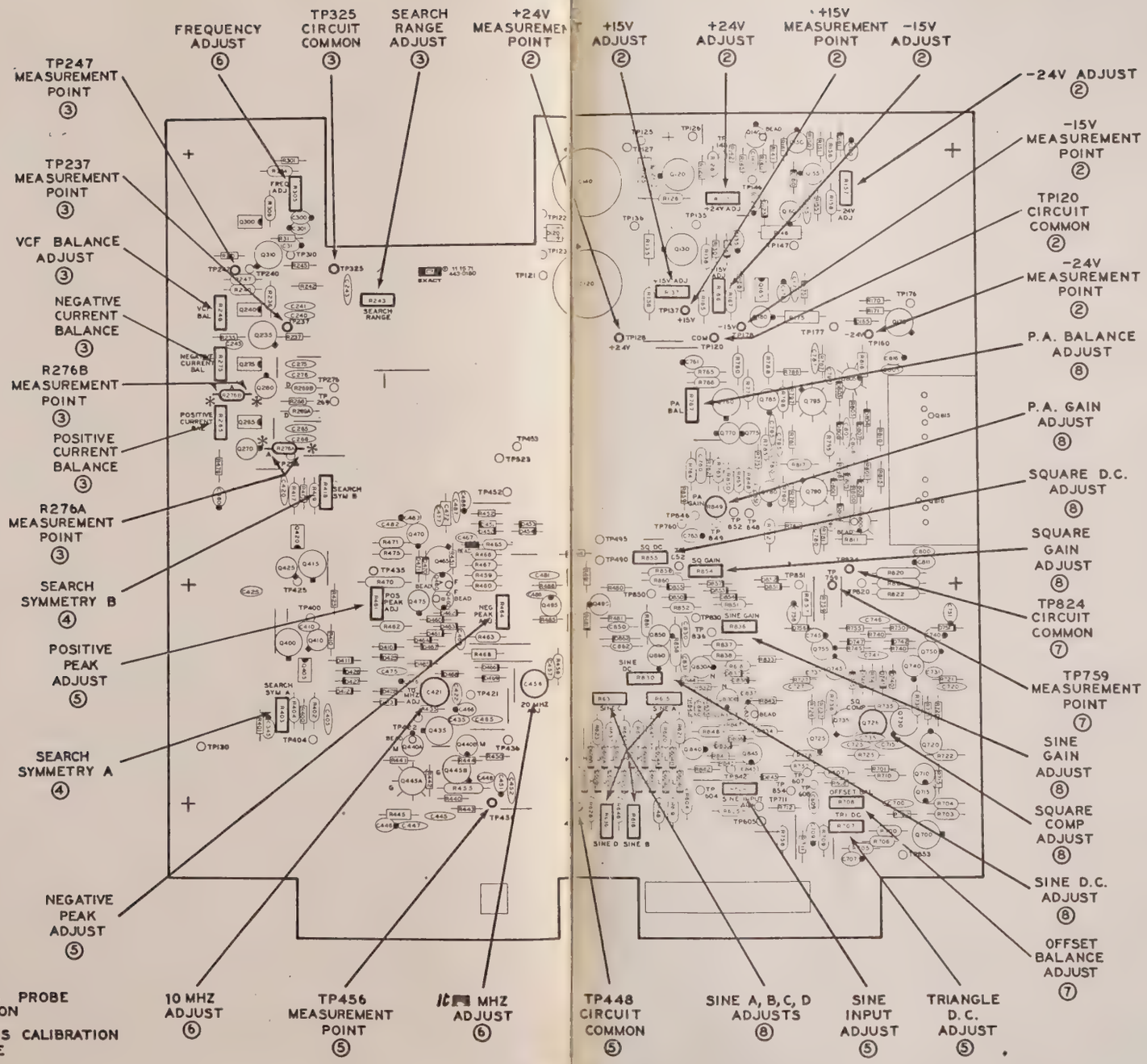
Return the multiplier dial to a setting of 1.0. Note that the frequency then is 1.0 times the range setting of 1K or 1 kilohertz. Turn the inner dial of the multiplier to X and note that the generator frequency then has increased to 10% over the 1KHz or 1.1KHz. Return the inner dial to 0. Turn the outer dial to .9 and note then that the generator frequency is .9 times 1K or 900 hertz. Turn the inner dial up from 0 to X and note then that the frequency of the generator can be changed from 900 to 910, 920, 930 etc. on up to 1,000 hertz again. Return the inner dial to 0. Turn the outer dial through each of its steps and note the generator frequency can be continuously varied from an overrange of 1.1 down to .1 times the range frequency setting, or in other words from 100 hertz to 1 kilohertz. Rotate the outer dial to the position marked S and note then that the inner dial will cause the generator frequency to be varied from a maximum of the 10% overrange or 1.1 times 1 kilohertz down to 1/1000th of the 1 kilohertz or approximately 1 hertz. This is the search mode of operation providing the continuously variable 1000 to 1 range. Reset the inner dial to 0.

12. VCF

Connect an external DC voltage supply to the VCF input connector and note then that as the generator is at 1 hertz from the previous step above the generator frequency can be increased by applying the 0 to 5 volts to the VCF input connector. Rotate the search control to X and apply a negative 0 to 5 volts to the VCF input connector and note that the frequency can be reduced from the 1.1 kilohertz down to the lower frequency of 1 hertz by applying negative 5 volts. Note that in no case should the generator frequency be increased beyond the 1.1 times the range setting, nor should it be lowered below 1Hz or 1/1000th of main dial. Return Multiplier to 1.0.

SECTION 3

CIRCUIT DESCRIPTION


FREQUENCY ADJUST ⑥
TP325 CIRCUIT COMMON ③
SEARCH RANGE ADJUST ③
+24V MEASUREMENT POINT ②
+15V ADJUST ②
+24V ADJUST ②
+15V MEASUREMENT POINT ②
-15V ADJUST ②
-24V ADJUST ②
TP247 MEASUREMENT POINT ③
TP237 MEASUREMENT POINT ③
VCF BALANCE ADJUST ③
NEGATIVE CURRENT BALANCE ③
R276B MEASUREMENT POINT ③
POSITIVE CURRENT BALANCE ③
R276A MEASUREMENT POINT ③
SEARCH SYMMETRY B ④
POSITIVE PEAK ADJUST ⑤
SEARCH SYMMETRY A ④
NEGATIVE PEAK ADJUST ⑤
-15V MEASUREMENT POINT ②
TP120 CIRCUIT COMMON ②
-24V MEASUREMENT POINT ②
P.A. BALANCE ADJUST ⑧
P.A. GAIN ADJUST ⑧
SQUARE D.C. ADJUST ⑧
SQUARE GAIN ADJUST ⑧
TP824 CIRCUIT COMMON ⑦
TP759 MEASUREMENT POINT ⑦
SINE GAIN ADJUST ⑧
SQUARE COMP ADJUST ⑧
SINE D.C. ADJUST ⑧
OFFSET BALANCE ADJUST ⑦
10 MHZ ADJUST ⑥
TP456 MEASUREMENT POINT ⑤
20 MHZ ADJUST ⑥
TP448 CIRCUIT COMMON ⑤
SINE A, B, C, D ADJUSTS ⑧
SINE INPUT ADJUST ⑤
TRIANGLE D.C. ADJUST ⑤

NOTES:

1. * INDICATES PROBE CONNECTION
2. ○ INDICATES CALIBRATION SEQUENCE

FIGURE 4.1.0
ADJUSTMENT LOCATION DETAIL Ⓓ

3.1.0 BLOCK DIAGRAM (Figure 3.1.1)

The basic generator loop utilized in this waveform generator consists of a pair of current sources alternately charging and discharging a timing capacitor. The triangular waveform generated in this timing capacitor is applied to a high input impedance triangle buffer amplifier which then applies the triangular signal to the bi-stable level detector. The output of this level detector is then fed back to alternately switch the current sources thus the loop is closed forming a free running generator. The level detector is used to switch the current sources at a predetermined point on the triangle thereby generating a constant amplitude triangle regardless of frequency of operation. Having generated a triangle of constant amplitude the frequency then is porportional to the timing capacitance and the current supplied to the capacitor from the constant current sources. Decade values of frequency are selected by decade selection of the timing capacitors and decade selection of the constant current sources. Variable frequency adjustment is accomplished by variable adjustment of the current sources through application of a DC voltage. For alternately charging and discharging the range capacitors one constant current source is a positive source and the other is a negative. In order that these can be externally controlled with a single DC voltage a pair level shifting amplifiers are supplied that convert a single input voltage to the voltages necessary to drive the positive and negative current sources. The positive and negative level shifting amplifiers are driven by the single VCF amplifier that can accept a signal either from the generator Multiplier dial or from an external DC voltage. The Multiplier dial receives its signal from a constant voltage amplifier called the Frequency supply.

This basic generator loop by nature provides a triangular waveform and a square waveform that can be processed and used as output signals to provide two waveforms. The triangular waveform can be processed through the sine converter to provide a sinusoidal waveform. The triangular waveform available at the output of the triangle buffer can be applied directly to the preamp through the function switching network. This then provides the triangular output waveform. The square waveform from the level detection network is applied directly to the square amplifier which then goes directly to the preamplifier. The square amplifier by nature can accept a DC signal from the function switching network to either activate or deactivate its operation. For sinusoidal operation the triangular waveform from the triangle buffer is supplied through the function switching network to the sine converter. The output of the sine converter is then fed to a sine amplifier which boosts the operating voltage level of the waveform. This waveform is then applied back through the function switching network to the preamplifier. The preamplifier utilized in this generator is used to boost the operating signal levels generated by the basic generator loop to something suitable for processing in the power amplifier. The preamp is also used to provide the offset functions which decrease the amplitude of the generated waveform to one-half and offset it to a value that maintains one peak at 0 volts. The output of this preamp is applied directly to the amplitude potentiometer which selects the amplitude applied to the power amplifier. The power amplifier can accept not only this amplitude signal but offset signals from the external input or the variable offset control. The output of the power amplifier is directly applied to the step attenuator which can

3.1.0 BLOCK DIAGRAM (Continued)

attenuate the signal in fixed db steps. Output of the attenuator is the main output connector for the generator. There are six power supplies in this generator, two of them being the unregulated raw supplies available directly at the filter capacitors. This voltage is a nominal 31 volts which is stepped down through the positive regulators for a plus 24 volt supply and a minus 24 volt supply. The plus and minus 24 volt supplies are used to provide voltage for the constant current sources as well as for the power amplifier. The plus and minus 24 volt supplies are reregulated through the plus and minus 15 volt regulators to provide all the operating potentials necessary for operation of the other circuitry.

3.2.0 CIRCUIT DESCRIPTION

3.2.1 POWER SUPPLY (Figure 6.2.1)

The primary power for this instrument is supplied through the line cord to fuse F-100 which is selected for each voltage of operation. The primary power is then applied through the main power switch S-100 to the transformer primary and line voltage switch S-101A. The Line Voltage switch S-101 selects the method of connection for the primary taps so that a selection is available as to which line voltage the instrument will operate at. Transformer T-100 steps down the operating potentials of the input primary power so that the proper voltage is developed through the usage of diode bridge D-120A and filter capacitors C-120 and C-140. This full wave center tapped bridge rectifier setup provides both positive and negative operating potentials of sufficient magnitude to be regulated through the usage of the plus and minus 24 volt regulators. Integrated circuit Q-120 is a self contained voltage reference and error amplifier. The output of this error amplifier is fed to series pass transistor Q-125 which enhances the current carrying capability of Q-120. Resistor R-125 is a current sensing resistor that allows Q-120 to reduce the output voltage of the supply in the event the current reaches a predetermined value. The voltage feedback, necessary for the error amplifier, is derived through the usage of the voltage divider R-126 through R-128. The potentiometer R-127 provides for a vernier adjustment in the power supply voltage. Diode D-125 is used to prevent accidental application of negative voltage to the positive regulator. Application of negative voltage would damage the integrated circuit. Capacitor C-125 prevents the build up of transient voltage at the output of the supply under varying load conditions. The instrument power indicator I-100 is operated from the regulated 24 volt supply. The positive 24 volt supply is applied to a combination of Q-130 and Q-135 so that it can be re-regulated to provide a source of plus 15 volts. Integrated circuit Q-130 contains its own internal reference voltage and error amplifier so that when used in conjunction with series pass transistor Q-135 a precision source of power supply voltage is available. Resistor R-135 provides a current sensing voltage so that current limiting can be provided at a predetermined value. The voltage feedback signal necessary for closed loop operation is provided by resistive divider R-136 through R-138. Potentiometer R-137 provides for vernier adjustment in the value of the output voltage of the regulator. Diode D-135 prevents damage in the event of accidental application of a negative voltage to this positive regulating system. Capacitor C-135 prevents a voltage buildup due to transient loading on the output of the power supply. Transistors Q-140 through Q-160 provide a regulation of the negative raw voltage such that a minus 24 volts is produced. This regulator utilizes the positive 24 volt supply as a reference. Resistor R-156 through R-158 forms a voltage divider between the positive 24 volts and the negative 24 volts supply. Being that the adjustable potentiometer is in the middle of two equal and opposite resistors the voltage value developed at the center when equal opposing voltages are applied will be zero. A differential pair Q-150 and Q-155 then amplifies the difference between the voltage developed at the swinger of the potentiometer and a ground reference provided through resistor R-150. The Output signal then from this difference is applied to transistor Q-140 through R-141. Transistor Q-140 is phase compensated through capacitor C-141 and R-142 and its output then as applied through R-145 to the base of the series pass transistor Q-145.

3.2.1 POWER SUPPLY (Continued)

Resistor R-146 senses the current output of the supply by providi ng a voltage porportional to current that is applied to the base-emitter junction of transistor Q-160. Upon reaching the predetermined current limit, transistor Q-160 begins drawing current through diode D-160 and resistor R-161 upsetting the balance of the differential pair Q-150 and Q-155 so that output voltage is reduced. Capacitor C-160 prevents a voltage build up due to transient loading on the output of the power supply. Diode D-161 prevents accidental damage in the event of application of a reverse bias voltage to this supply. The negative 24 volts from this regulator then is supplied to the negative 15V regulator made up of transistors Q-165 through Q-180. Integrated circuit Q-165 is an operational amplifier whose input is derived from the resistive divider R-165 through R-167. The output of this voltage di vider is the difference between the positive 15 volt supply and the negative 15 volt supply. When these two supplies are equal and opposite the error voltage supplied to the operational amplifier Q-165 is zero and the supply is at rest or in a quiescent condition. The output of the operational amplifier Q-165 is fed through a level shifting diode D-165 to the bias and stablizing resistors R-170 and R-171. It is then applied to the base of transistor Q-170 operated as an emitter follower whose output is directly applied to the series pass transistor Q-175. Transistor Q-175 is operated as a series pass emitter follower transistor such that the operating current level of this supply can be supplied. Resistor R-175 provides a voltage porportional to current such that transistor Q-180 can be biased on at a predetermined current level. When this current level is reached Transistor Q-180 begins drawing current from the input of the operational amplifier Q-165. This current drawn from the input lowers the output voltage so that the output in effect will be current limited. Capacitor C-175 and C-176 prevent voltage build up at the output of the supply in the presence of varying loads on the supply. Diode D-175 prevents the application of reverse biasing potentials to the regulator that could result in damage.

3.2.3 FREQUENCY CONTROL CIRCUITRY (Figure 6.3.1)

The frequency supply is a closed loop buffered operational amplifier system that provides a voltage for the multiplier dial. Operational amplifier Q-300 receives its input signal from the combination of R-304 and 305. Potentiometer R-305 provides for a small vernier adjustment of the output voltage of this supply. R-306 is the feedback resistor that provides the necessary closed loop voltage gain. Transistor Q-310 is operated as an emitter follower to boost the current carrying capability of the frequency supply. The output of this frequency supply is applied directly to the rotary switch wired up as a Kelvin-Varley divider. This Kelvin-Varley divider has an extra position that allows the vernier potentiometer to span the full output voltage capability of the frequency supply. The output then of this Kelvin-Varley divider used as a frequency multiplier is applied through a summing resistor to the VCF amplifier. The VCF amplifier is capable of accepting a signal from the external VCF input or from the Multiplier dial. Integrated circuit Q-240 is an operational amplifier with a emitter follower buffer transistor Q-235. Q-235 enhances the current carrying capability of the VCF amplifier. Potentiometer R-243, the search range adjustment, injects a small current to the input of the VCF amplifier so that under normal operating conditions of the Multiplier dial, zero frequency can never be obtained and the maximum range of 1/1000th of the dial frequency is obtained. Potentiometer R-246, the VCF balance control, compensates for the offset voltage of the amplifier Q-240. Resistors R-235 and R-237 provide the proper operating biases for the emitter follower transistor Q-235. The output of the VCF amplifier at the emitter of Q-235 is applied directly to the non-inverting input of the operational amplifier Q-275. It is also processed through frequency control connection schematic 2A for application to the input resistor of Q-265 or 269A. The output voltage at the output of the VCF amplifier is a nominal negative 5 millivolts to negative 5 volts for a frequency range of 1000 to 1. The most negative voltage being the highest frequency.

The level shift amplifiers are in reality voltage variable current sources whose outputs are taken from a pair of matched precision resistors referenced to equal and opposite power supplies. One level shift amplifier being driven from the negative input or inverting input and the other being driven in the non-inverting input provides equal and opposite polarities of output voltages suitable for driving the main current sources in the generator loop. The signal return path for R-269B at the input of Q-275 is routed through the frequency control connection schematic 2A. The current balance potentiometers R-265 and R-275 are utilized to balance out the internal offset voltage of the operational amplifiers Q-265 and Q-275. The field effect transistors Q-270 and 280 are used to buffer the output of the level shifting amplifiers in such a manner that the leakage currents are very small and output impedance is very high.

3.2.4 VARIABLE SYMMETRY (Figure 6.3.2)

Having noted from schematic 2, Frequency Control Circuitry, that resistors R-269A and B a matched pair, are the input and gain setting resistors for the level shifting amplifiers it can be shown then that with the activation of the Symmetry switch, S-265, a variable potentiometer can be added to this input resistance for a variable symmetry network. The potentiometers are connected such that when the potentiometer is in the center the resistance in R-268A is the same as R-268B. They are also wired such that as you turn the symmetry control the resistance increases in one potentiometer and decreases in the other. This increase in resistance in one level shifting amplifier input resistor and decrease in resistance in the other unbalances the output of the level shifting amplifier in direct porportion to the rotation of the variable symmetry dial creating and unbalance in the charging and discharging current in the main generator loop thereby creating a continuously variable control over the symmetry of the triangular waveform that is generated.

3.2.5 GENERATOR LOOP CIRCUITRY (Figure 6.4.1)

The positive and negative current sources receive their equal and opposite driving voltages from the level shifting amplifiers in schematic 2. The positive and negative current sources are operational amplifiers whose inputs are buffered with dual field effect transistors and whose output is taken from a single field effect transistor. The input signal at the gate of the dual field effect transistor Q-400 is applied to the positive input of the operational amplifier Q-405. The output of the operational amplifier Q-405 is applied to the gate of the field effect transistor Q-410 and as far as the closed loop amplifier is concerned the field effect transistor is operated as a source follower. The negative feedback for closed loop operation is from the source connection of the field effect transistor back to the gate input connection of the dual field effect transistor Q-400. The output of this source follower then is taken from R-403 center tap and applied to the negative input of the operational amplifier Q-405. The effective input resistor then to this closed loop amplifier is the set of range resistors R-405 through 409A. The input voltage to this current source varies between approximately plus 15 to plus 10 volts. Therefore, being operated as a closed loop amplifier the voltage at tp400 will remain the same as the input voltage and the current flowing through the range resistors will be controlled by the input voltage. The nature of a field effect transistor is such that the source current is very nearly equal to the drain current and thus the current flowing from the drain connection is controlled by the closed loop amplifying system. The negative current source comprised of Q-415, Q-420 and Q-425 operates in the same manner except that it is referenced instead to the negative 15 volt supply at the range resistors. The input voltage varies from negative 10 to negative 15 volts. The power supply connections for the operating potentials of the dual field effect input transistors and the operational amplifiers are derived from the plus and minus 24 volts available from the regulators. The value of current then supplied by these current sources to the timing capacitors is controlled by the input to the VCF amplifier and the range resistors. The positive and negative currents from the current sources are continually applied to the switching bridge which then allows the level detector square wave signal to apply alternately either one or the other of the current sources to the timing capacitor. The range switch selects a matched set of capacitors for different decade ranges of frequency operation. The triangular voltage developed across the timing capacitor is applied to a triangle buffer amplifier through filter R-435 and C-435. The triangle buffer amplifier is comprised of a very high input impedance source follower whose output is applied to two stages of emitter followers. Q-435A, Q-440A and Q-445A are these transistors. The operating bias potential for these transistors to operate with a zero offset from output to input is supplied by the matched counterpart to each device thus Q-435B, Q-440B and Q-445B. The field effect transistor Q-435B is operated at a gate source potential equal to the base emitter drops of the two transistors Q-440B and Q-445B. This field effect transistor then forces Q-435A, another field effect transistor, to operate at the same drain current thereby requiring the same gate to source potential. This potential being equal to the two transistor drops then realizes a zero output voltage from the input at C-435 to the output at tp456. Q-445A then being an emitter follower provides a low output impedance source of

3.2.5 GENERATOR LOOP CIRCUITRY (Continued)

triangular voltage to be applied to the level detector and to the function switching networks for processing in the output amplifiers and etc. The level detector consists of transistors Q-460 through Q-475. This detector receives its input through the compensated voltage divider consisting of R-458 and R-459. Capacitors C-455, 456 and 457 provide a high frequency lead network that compensates for the high frequency responses of the level detector network. Transistor Q-465 is a constant current source providing the operating currents for differential pair Q-460A and B. This differential pair of transistors is used to compare the triangular voltage developed at the divider network to the square wave voltage developed at resistor R-460. The square wave voltage developed at resistor R-460 is generated through the use of adjustable current supplies switched in through the use of the diode switching bridge network D-460 through D-463. The output of the differential input pair is applied to another differential pair, transistors Q-470 and Q-475. Diodes D-470 and D-471 clamp the collector voltages so that a small differential voltage can exist between the two. This maintains a current mode of operation enhancing high speed operation. The collector of transistor Q-475 and its load resistor R-468 provides a square wave that is clamped in amplitude by the limiting bridge diodes D-464, 465, etc. This square wave voltage is applied to the reference switching bridge D-460 through D-463 providing the positive feedback necessary for a bi-stable operation. Resistor R-451 and Diode limiting bridge D-451 through D-454 and resistor R452 is used to modify the reference voltage in the level detector developed at R460 for purposes of externally synchronizing the main generator loop.
The square wave output from the level detector is also fed to the sync output buffer through diodes D-481 and D-482. It also is applied to the switching bridge that selects either the positive or negative current source for the timing capacitors and the square amplifier that generates the square waveform that is applied to the pre-amplifier.

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Figure 6.5.1)

The sine converter network receives its signal from the function selector only when a sine waveform is selected. The input level to this sine converting network is adjusted through potentiometer R-624 and the other associated resistors. The triangular input voltage is applied to all four of the diode switching bridges simultaneously, and the output of these bridges is summed together in a single resistor R-618. Various resistors such as R617, R-620 and R-637 are used to provide voltage breaking points that allow the currents to be changed in successive addition as the input voltage to the sine converting network goes from zero volts to say a positive or negative voltage. The sine waveform then appearing at the output summing resistor R-618 is applied to the input of the sine amplifier at Q-830A. Capacitor C-831 removes the high frequency components of the waveform before processing in the sine amplifier. The sine amplifier is a closed loop amplifier whose positive or non-inverting input is the base of Q-830A. Q-830A and 830B is a differential amplifier whose output is applied in Cascode form to transistor Q-835. The base of transistor Q-835 is elevated to a bias suitable for the maximum output voltage by diodes D-838 and temperature compensating diode D-837. The output

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Continued)

of this stage is applied through two biased diodes D-835 and D-836 to the compound emitter followers Q-840 and Q-845. The negative feedback necessary for closed loop operation is provided by resistor R-846 to the effective input resistor R-847. Also paralleling R-847 is a vernier adjustment sine gain potentiometer R-836 and its limiting resistor R-837. The output of this sine amplifier is applied directly back to the function switching network through R-842. The square signal from the level detector in the main generator loop is applied to the current mode switch called a square amplifier through level shifting diode D-862. Transistors Q-860 and Q-850 are the current mode switch whose inactive input at the base of Q-850 is controlled by the combination of the Diodes D-850, 857 and the level adjusting potentiometer R-854. Adjusting the square gain potentiometer R-854 varies the base bias at the base of transistor Q-850 therefor varying its emitter bias through R-860 varying the level of the square output voltage. The collector load resistor for this output stage is R-855 and 856. R-855 being the square DC adjust potentiometer. Diode D-855 is a disconnect diode which allows the square amplifier to be deactivated by an external DC control signal available from the function switching network. This DC control signal is also applied to the base bias of Q-850 deactivating its operation when the square signal is not required. The output of this square amplifier is applied directly to the input of the pre-amplifier through R-608. The pre-amplifier then accepts signals through R-608 from the square amplifier when it is activated or from the function switching network through R-607. The pre-amplifier is a closed loop amplifier whose gain setting feedback resistor is R-757. This amplifier is a high performance amplifier with two signal paths, one containing the path for lower frequencies from DC to approximately 100 kilohertz and the other path for frequencies above 100 kilohertz. The feedback resistor R-757 is paralleled with a resistor of the same value R-758 for the fixed offset function. This reduces the gain of the amplifier by one-half and applies the fixed offset potential through R-708 and R-709.

The high frequency portion of this amplifier is comprised of two sets of Cascode amplifiers, that is, one set being Q-720 and Q-730 referenced to the plus 15 volts supply and the other being Q-725 and Q-735 referenced to the minus 15 volt supply. The outputs of these two Cascode amplifiers are connected together through bias diodes D-740 through D-746. The bias diodes provide the necessary quiescent operating bias for the input emitter followers Q-740 and Q-745. The summing junction or actual input connection to the amplifier is at the junction of the two high frequency input capacitors C-715 and C-725. The output of the input emitter followers Q-740 and Q-745 is applied to the output emitter followers through the bias diodes D-742 and D-747. Transistors Q-750 and Q-755 provide the necessary output current carrying capability through degeneration resistors R-750 and R-755. The Cascode stage comprised of Q-720 and Q-730 is operated as a slightly higher quiescent current than the opposite Cascode amplifier Q-725 and Q-735. This slightly higher current allows transistor Q-715 to be biased on at a quiescent potential thereby allowing a point to inject the signals from the low frequency or DC channel in the amplifier. The input connection to the amplifier applies the low frequency or DC signals through resistor R-701 to the base

3.2.6 OUTPUT CONDITIONING CIRCUITRY (Continued)

of differential transistor Q-700. The differential output available from transistor Q-700 at the collectors and R-703 and R-704 is applied directly to another differential pair made up of transistors Q-710 and Q-715. The single ended output from from transistor Q-715 is applied directly through resistor R-715 to the Cascode amplifier Q-720 and Q-730. Potentiometer R-707, named the triangle DC adjust, compensates for variations in the offset of the differential amplifier Q-700.

The signals available from the output of the pre-amplifier are processed through de-coupling resistor R-759 to the amplitude front panel control resistor R-862. This potentiometer and its bottoming resistor R-859 provide a vernier control of the output amplitude of the generator. These signals are applied directly through gain controlling potentiometer 849 and amplitude setting resistor R-850 to the input of the closed loop output amplifier. The variable DC offset at potentiometer R-853 can also be applied through its switch S-837 to a gain setting resistor R-852 and to the input of the amplifier. Resistor R-848 provides a point for externally injecting a DC offset signal to the closed loop output amplifier.

The output amplifier is very similar to the pre-amplifier. This output amplifier has two signal paths for processing the input signals. One for low frequency signals from DC to approximately 100 kilohertz and the other for frequencies of approximately 100 kilohertz and above. The higher frequency signal path flows from the input connection through capacitors C-780 and C-785 to the bases of the two Cascode amplifiers. One amplifier being transistors Q-780 and Q-790 and the other being transistors Q-785 and Q-795. The signals are simultaneously applied to both amplifiers and the output then of these amplifiers are connected together and applied to the output emitter followers. Diodes D-800 through D-806 are bias diodes for generating a quiescent current for the input emitter follower stages Q-800 through Q-805. Bias diodes D-802 and D-807 provide a quiescent bias for the output transistors mounted to the heat sink Q-810 and Q-815. Degeneration resistors R-810 and R-815 applies the signal directly to the gain setting feedback resistor R-817 and the output impedance resistors R-820 through R-822. The Cascode amplifier referenced to the positive supply Q-780 and Q-790 is operated at a slightly higher current than the Cascode amplifier referenced to the negative supply. This higher current allows a small bias current to be drawn through R-775 by the differential amplifier Q-770 and Q-775. This connection allows injection of the DC and low frequency signals to be processed through the amplifier. The low frequency input signals are coupled from the input connection through resistor R-761 to the base of the differential amplifier Q-760. The differential output from this amplifier from its collectors and resistors R-763 and R-764 are applied directly to the differential amplifier Q-770 and Q-775. The single ended output from Q-775 is applied directly to the Cascode through R-775. Resistor R-767 allows compensation for the voltage offset in the differential amplifier Q-760.

The attenuator is a series of T pad attenuators that can be either switched in or out by the manual pushbuttons in the front panel of the instrument. These T pad attenuators are arranged such that the 50 ohm transmission line impedance is maintained regardless of which or how many of the attenuators is activated.

3.2.7 FUNCTION SWITCHING (Figure 6.5.2)

The function switching connections at switch S-700A accepts the triangle generated in the main generator loop. It processes it through to the sine converter for the sine waveform, through the switch to switch deck S-700B which applies it to the pre-amplifier for the triangular waveform, and terminates it in resistor R-606 for the square waveform. Switch deck S-700B terminates the connection of the pre-amplifier input for the square mode or function and accepts the triangle wave from switch deck S-700A in triangle. It also accepts the sine amplifier signal for the sine wave function. Switch deck S-700K either activates or deactivates the square amplifier by grounding the proper connection to circuit common.

SECTION 4

CALIBRATION PROCEDURE

4.1.0 EQUIPMENT REQUIRED

The unit must be operated for one hour with the covers in place before calibration and the output continually terminated in 50Ω.

The following equipment or suitable equivalents of known accuracy are required for complete calibration of the Model 7030.

Oscilloscope D.C. to 90MHz Differential input with 5mv/cm sensitivity.
Tektronix 7704 with 7A13 plug-in.

Counter-Timer 11MHz to 10,000 seconds.
Fairchild 8200 or equivalent.

Digital Voltmeter .01% accuracy with 1000 megohm input impedance floating inputs.
Fairchild 7000.

Harmonic Distortion Analyzer .1% Residual Distortion
Hewlett Packard 333.

1. INITIAL CONTROL SETTINGS

POWER SWITCH	On
MULTIPLIER	1.0
RANGE	1K
VAR. SYM.	Not Activated
FUNCTION	Triangle
AMPLITUDE	Full Clockwise
ATTENUATOR	Not Activated
OFFSET	Not Activated

2. Using DVM: (Fig. 4.1.0)

A. Probe +24V measurement point and adjust the +24V Adjust for +24.00V ± .01V.
B. Probe -24V measurement point and adjust the -24V Adjust for -24.00V ± .01V.
C. Probe +15V measurement point and adjust the +15V Adjust for +15.00V ± .01V.
D. Probe -15V measurement point and adjust the -15V Adjust for -15.00V ± .01V.

3. Using DVM (with tp325 as Common)

A. Probe tp247 and adjust VCF Bal Adjust for 0.000V ± .1mv.
B. Set Multiplier Dials to .10 and measure the voltage at tp237.
C. Connect DVM across R276B (refer to Adjustment Loc. Detail Figure 4.1.0) and adjust Negative Current Bal Adjustment for a reading of the same absolute value of the same reading obtained in "B" above ± .5 mv.
D. Connect DVM across R276A (refer to Adjustment Loc Detail Figure 4.1.0) and adjust the "Positive Current Bal" Adjust for an absolute value of the same reading obtained in "B" above ± .5 mv.
E. Set Multiplier to S-0 and probe tp237. Adjust the Search Range Adjust for a voltage between -4 and -5 millivolts.

4. Set Function to Square Range to 1M, Multiplier to S-X. Monitor the output with the Oscilloscope.

A. Using oscilloscope set to .1μ per Cm, check for approximately 1 cycle of square wave on screen.
B. Set Multiplier to S-0 (against the stop) and set the oscilloscope Horizontal Sweep Speed for .1 ms per Cm. Adjust Search Sym A and Search Sym B for a time Symmetrical square wave that is slightly greater (approximately 2 millimeters) than 10 Cm. at .1 ms per Cm.

5. Set Function to Triangle, set Range to 1K, set Multiplier to 1.0.

A. Monitor 456 using tp448 as a ground with the comparator oscilloscope. Adjust the Positive Peak Adjust for a positive triangle peak voltage of +1.000V ± 1 mv. Adjust the Negative Peak Adjust for a negative triangle peak voltage of -1.000V ± 1 mv.

6. Set Function to Square and monitor the main output of the generator with the Frequency Counter.

A. Adjust the Frequency Adjust for a generator frequency of 1.000 KHz. Check each range for timing accuracy for the .01Hz range to the 1MHz range. (It may be necessary to re-adjust the Frequency Adjustment so that all ranges fall within specifications.)
B. Set Multiplier to .10 and set the Range to 10M. Adjust the 1MHz Adjust for a frequency of 1.00MHz.
C. Set Multiplier to 1.0 and Adjust the 10MHz Adjust for a frequency of 10.0 MHz:
D. Repeat steps B and C as necessary to maintain calibration between 1 and 10MHz.

7. Reset Function to Triangle and Reset Range to 1K, Multiplier to 1.0.

   A. Connect oscilloscope to tp759 using tp824 as a ground. Adjust the Triangle D.C. Adjust for Symmetrical triangle above ground to ± 5mv.

   B. Depress Fixed Offset and adjust the Offset Bal Adjust for a triangle starting at Zero Volts ± 5 mv.

8. Deactivate Offset and Neg. Connect oscilloscope to terminated main output.

   A. Adjust PA Bal Adjust (D.C.) and the PA Gain Adjust for a triangle of 15.00 V +20/-0 mv peak to peak.
   B. Switch Function to Square and adjust the Square Gain Adjust and the Square D.C. Adjust for a square wave of 15.00V +20/-0 mv.
   C. Switch Function to Sine and connect the harmonic distortion analyzer to the main output (terminated). Adjust the Sine Input Adjust and Sine A, Sine B, Sine C, and Sine D Adjusts for minimum Sine distortion.
   D. Connect oscilloscope to main output (terminated) and adjust the Sine Gain Adjust and Sine D.C. Adjust for an output of 15.00V +20/-0 mv peak to peak.
   E. Set Function to Square and Range to 10M. Adjust the Square Comp. Adjust for best waveform quality. (Proper Rise time overshoots specifications and Sine rolloff).

SECTION 5

PARTS LIST

CODE LIST OF MANUFACTURERS

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Sprgs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00334	Humidaol Co.	Colton, Calif.
00335	Westrex Corp.	New York, N.Y.
00373	Garlock Packing Co., Electronic Prod. Div.	Camden, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp, Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Eng. Labs, Inc.	Burlington, Wis.
00853	Sangamo Electric Co. Ordill Div. (Caps)	Marion, Illinois
00866	Coe Engineering Co.	Los Angeles, Calif.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
0112:	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc. Transistor Prod. Div.	Dallas, Texas
01349	The Allionce Mfg. Co.	Alliance, Ohio
01561	Chassis-Trak Corp.	Indianapolis, Inc.
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01930	Amerock Corp.	Rockford, Illinois
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferrocube Corp/Amer.	Saugertim, N.Y.
02786	Cole Mfg. Co	Palo Alto, Calif
02860	Amphenol-Borg El. Corp.	Chicago, Illinois
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vecoline Company of America, Inc.	Old Saybrook, Conn.
02797	Hopkins Engineering Co.	San Fernando, Calif.
03508	G.E. Semiconductor Products Dept.	Syracuse, N.Y.
03705	Apex Machine and Tool Co.	Dayton, Ohio
03797	Eldema Corp.	El Monte, Calif.
03877	Transitron Electronic Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co.	Morristown, N.J.
03984	Air Marine Motors, Inc.	Los Angeles, Calif.
04009	Arrow, Hart and Hegeman Electric Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Elmenco Products Co.	New York, N.Y.
04222	M-Q, Division of Aerovox	Myrtle Beach, S.C.
04298	Elgin National Watch Co. Electronics Div.	Burbank, Calif.
04354	Precision Paper Tube Co.	Chicago, Illinois
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Prod., Inc. Electronic Tube Div.	Mountain View, Calif.
04713	Motorola Semicon. Prod.	Phoenix, Ari ona
04732	Filtron Co/Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Illinois
04777	Automatic Elect. Sales Corp.	Northlake, Illinois
04811	Sequoia Wire/Cable Co.	Redwood City, Calif.
04813	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Co.	Chicago, Illinois
05006	20th Century Plastics	Los Angeles, Calif.
05277	Westinghouse/Semicon. Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05593	Illumitronic Eng. Co.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Illinois
05728	Tiffen Optical Co.	Roslyn Heights, L.I., N.Y.
05729	Metropolitan Telecomm. Corp Metro Cap Div.	Brooklyn, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	The Bassick Co.	Bridgeport, Conn.
06175	Bausch and Lomb Optical	Rochester, N.Y.
06402	E.T.A. Products/Amer.	Chicago, Illinois
06475	Western Devices, Inc.	Inglewood, Calif.
06540	Amatom Elect. Hardware Co.	New Rochelle, N.Y.
06555	Beede Electrical Inst. Co.	Penacook, N.H.
06751	U.S. Semicon Div. of Nuclear Corp/Amer	Phoenix, Ariz.
06812	Torrington Mfg Co, West Div.	Van Nuys, Calif.
07088	Kollsman Electric Co.	Van Nuys, Calif.
07115	Corning Glass Works Electronics Comp. Dept.	Bradford, Pa.
07-26	Digitron Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Fitzsimons Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
0726	Avnet Corp.	Los Angeles, Calif.
07263	Fairchild Semiconductor Corp.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	The Birtcher Corp.	Los Angeles, Calif
07700	Technical Wire Products	Springfield, N.J.
07910	Continental-Device Corp.	Hawthorne, Calif.
07933	Rheem Semiconductor Corp.	Mountain View, Calif.
07966	Shockley Semi-Conductor Labs	Palo Alto, Calif.
07980	Boonton Radio Corp.	Boonton, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Elmin, DeHart, Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario
08717	Sloan Company	Burbank, Calif.
08718	Cannon Elect Co., Phoenix Div	Phoenix, Ariz.
08799	CBS Elect. Semiconductor Oper., Div. C.B.S., Inc.	Lowell, Mass.
08984	Mel-Ram	Indianapolis, Ind.
09026	Babcock Relays, Inc.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Atron Electronics	Sun Valley, Calif
09250	Electro Assemblies, Inc.	Chicago, Illinois
09569	Mallory Battery Co/Canada Ltd	Toronto, Ontario, Canada
09664	The Bristol Company	Waterbury, Conn.
10024	Gen Trans. Western Corp.	Los Angeles, Calif
10411	T-Tal, Inc	Berkeley, Calif
10597	Exact Electronics, Inc	Hillsboro, Oreg
10646	Carborundum Co	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Tel of Calif., Inc	S. Pasadena, Calif.
11312	Microwave Elect. Corp.	Palo Alto, Calif
11534	Duncan Electronics, Inc.	Santa Ana, Calif.
11711	Gen Instr Semiconductor Div	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.

Code No.	Manufacturer	Address
11870	Melabs, Inc.	Palo Alto, Calif.
12136	Philadelphia Handle Co.	Camden, N.J.
12697	Clarostat Mfg. Co.	Dover, N.H.
12859	Nippon Elect. Co., Ltd.	Tokyo, Japan
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
13103	Thermalloy	Dallas, Texas
13396	Telefunken (G.M.B.H.)	Hannover, Germany
13835	Midland Mfg. Co.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components Inc.	Conshohocken, Pa.
14655	Cornell Dubilier El. Corp.	So. Plainfield, N.J.
14960	Williams Mfg. Co.	San Jose, Calif.
15003	Webster Elect., Co., Inc.	Brooklyn, N.Y.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15909	The Deven Co.	Livingston, N.J.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16352	Computer Diode Corp.	Lodi, N.J.
16688	De Jur-Amsco Corp.	Long Island City, N.Y.
16758	Delco Radio, Division of G.M. Corp.	Kokomo, Ind.
17109	Thermonetics, Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
18486	Radio Industries	Des Plaines, Illinois
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18873	E.I. Dupont and Co., Inc.	Wilmington, Del.
19315	Eclipse Pioneer, Div. of Bendix Aviation Corp.	Teterboro, N.J.
19500	Thomas A. Edison Industries Div. McGraw-Edison Co.	West Orange, N.J.
19701	Electra Manufacturing Co.	Kansas City, Mo.
20183	Electronic Tube Corp.	Philadelphia, Pa.
21228	Executive, Inc.	New York, N.Y.
21520	Fansteel Metallurgical Corp.	No. Chicago, Illinois
21845	The Fafnir Bearing Co.	New Britain, Conn.
21964	Fed. Telephone and Radio Corp.	Clifton, N.J.
24446	General Electric Co.	Schenectady, N.Y.
24655	G.I.F., Long Div.	Nela Park, Cleveland, Ohio
24655	General Radio Co.	W. Concord, Mass.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co/America, Inc.	Carlstadt, N.J.
26992	Hamilton Watch Co.	Lancaster, Pa
28480	Hewlett-Packard Co.	Palo Alto, Calif.
33173	GE Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm, Inc.	Chicago, Ill
36 96	Stanwyck Corp.	Hawkesbury, Ontario, Cd.
37942	P.R. Mallory and Co., Inc.	Indianapolis, Ind
39543	Mechanical Industries Prod.	Akron, Ohio
40920	Miniature Precision Bearings	Keene, N.H.
42190	Muter Co.	Chicago, Illinois
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Illinois
47904	Polarad Corp	Cambridge, Mass.
48620	Precision Thermometer/Inst.	Philadelphia, Pa.
49956	Raytheon Company	Lexington, Mass
52090	Rowan Controller Co.	Baltimore, Md.
63743	Ward Leonard Electric	Mt. Vernon, N.Y.
54294	Shallcross Mfg. Co.	Selm , N.C.
55026	Simpson Electric Co.	Chicago, Illinois
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Sorenson and Co., Inc.	S. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	N. Adams, Mass.
59446	Telex, Inc.	St. Paul, Minn.
59720	Thomas and Betts Co.	Elizabeth, N.J.
60741	Tripplett Electrical Inc	Bluffton, Ohio
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc	New York, N.Y.
65092	West Inst. Div. Doystrom	Newark, N.J.
66295	Wilkes Manufacturing Co.	Chicago, Illinois
66346	Wollensak Optical Co.	Rochester, N.Y.
70276	Allen Manufacturing Co.	Hartford, Conn.
70309	Allied Control Co., Inc.	New York, N.Y.
70319	Almetal Screw Prod. Co., Inc.	Garden City, N.Y.
70485	Atlantic India Rubber Works	Chicago, Illinois
70563	Amperite Co., Inc	New York, N.Y.
70903	Belden Manufacturing Co.	Chicago, Illinois
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71041	Boston Gear Works Div. of M.rray Co. of Texas	Quincy, Mass.
71218	Bud Radio Inc.	Cleveland, Ohio
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Allen D. Cardwell Elect. Prod. Corp.	Plainville, Conn.
71400	Bussmann Fuse Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Illinois
71450	CTS Corp.	Elkhart, Ind.
71468	Cannon Electric Co.	Los Angeles, Calif.
71471	Cinema Engineering Co.	Burbank, Calif.
71482	C.P. Clare and Co.	Chicago, Illinois
71590	Centralab, Div. Globe Union, Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Illinois
71700	The Cornish Wire Co	New York, N.Y.
71744	Chicago Miniature Lamp Wks	Chicago, Illinois
71753	A. O. Smith Corp Crowley Div.	West Orange, N.J.
71785	Cinch Mfg. Corp	Chicago, Illinois
71984	Dow Corning Corp.	Midland, Mich.
72092	Ettel-McCullough, Inc.	San Bruno, Calif.
72136	Electra Motive Mfg. Co, Inc.	Willimantic, Conn.
71707	Cato Coil, Co., Inc.	Providence, R.I.
72354	John E Fast and Company	Chicago, Illinois
72619	Dialight Corp.	Brooklyn, N.Y.
72656	General Ceramics Corp.	Keasbey, N.J.
72899	General Instrument Corp. Semiconductor Div.	Newark, N.J.
72758	Girard-Hoppis	Oakland, Calif.
72765	Drake Mfg Co.	Chicago, Illinois
72825	Hugh H. Eby, Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Illinois
72965	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Resistor Corp.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind
73076	H. M. Harper Co.	Chicago, Illinois
73138	Heliopot, Div. Beckman Instruments, Inc.	Fullerton, Calif.

Code No.	Manufacturer	Address
73293	Hughes Products Div. of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Electronic Co., Div. No. American Philips Co., Inc.	Hicksville, N.Y.
73490	Beckman Helipot Corp.	S. Pasadena, Calif.
73506	Bradley Semiconductor Corp.	Hamden, Conn
73559	Carling Electric, Inc	Hartford, Conn.
73682	George K. Garrett Co., Inc.	Philadelphia, Pa.
73734	Federal Screw Prod. Co.	Chicago, Illinois
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	The General Industries Co.	Elyria, Ohio
73846	Goshen Stamping and Tool	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Co.	San Jose, Calif.
74276	Signalite, Inc.	Neptune, N.J.
74455	J. M. Winne and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Illinois
74868	R.F. Prod. Div. of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75173	Jones, Howard B., Div. of Cinch Mfg. Corp.	Chicago, Illinois
75378	James Knights Co.	Sandwich, Illinois
75382	Kulka Electric Corp.	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Illinois
75915	Littlefuse, Inc.	Des Plaines, Illinois
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif
76433	Micamold Electronic Mfg. Corp	Brooklyn, N.Y.
76487	James Millen Mfg. Co., Inc.	Malden, Mass
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Monadnock Mills	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76854	Oak Manufacturing Co.	Crystal Lake, Illinois
77068	Bendix Pacific Div. of Bendix Corp.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phaostron Instrument and Electronic Co.	S. Pasadena, Calif
77250	Phaell Manufacturing Co.	Chicago, Illinois
77252	Philadelphia Steel and Wire Corporation	Philadelphia, Pa.
77342	Porter and Chamfield, Div. of American Machine/Foundry	Princeton, Ind.
77630	Radio Condenser Co.	Camden, N.J.
77638	Radio Receptor Co., Inc.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof, Div. of Illinois Tool Works	Elgin, Illinois
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn, Inc.	Pitman, N.J.
78452	Thompson-Bremer and Co.	Chicago, Illinois
78471	Tilley Manufacturing Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	Pasadena, Calif
78947	Ucinite Co.	Newtonville, Mass
79142	Veeder Root, Inc.	Hartford, Conn
79251	Wenco Mfg. Co.	Chicago, Illinois
79727	Continental-Wirt Elect. Corp.	Philadelphia, Pa.
75963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco, Div. of Sessions Clock Company	Morristown, N.J.
80120	Schnitzer Alloy Products	Elizabeth, N.J.
80130	Times Facsimile Corp.	New York, N.Y.
80131	Electronic Industries Assoc	Washington D.C.
80207	Any brand tube meeting EIA standards. Unimax Switch, Div. of W L Maxson Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Illinois
80294	Bourns Laboratory, Inc.	Riverside, Calif
80411	Acro, Div. Robershaw Fulton Controls Co.	Columbus, Ohio
80486	All Star Products, Inc.	Defiance, Ohio
80509	Avery Adhesive Label Corp.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	New York, N.Y.
80640	Stevens, Arnold Co., Inc.	Boston, Mass
81030	International Instruments, Inc.	New Haven, Conn.
81073	Greyhill Co.	LaGrange, Illinois
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Electronics Co.	Norwalk, Conn.
81349	Military Specifications	---
81415	Wilkor Products, Inc.	Cleveland, Ohio
81453	Raytheon Mfg. Co., Industrial Components Div, Industrial Tube Oper	Newton, Mass.
8-483	International Rectifier Corp.	El Segundo, Calif.
81541	The Airpax Products Co.	Cambridge, Mass.
81860	Barry Controls, Inc	Watertown, Mass
82042	Carter Parts Co.	Skokie, Illinois
82142	Jellen Electronics, Div. of Speer Carbon Co.	DuBois, Pa.
82170	Allen B. DuMont Labs, Inc.	Clifton, N.J.
82209	Maguire Industries, Inc	Greenwich, Conn.
82219	Sylvania Electric Prod., Electronic Tube Div.	Emporium, Pa.
82376	Astron Company	E. Newark, N.J.
82389	Switchcraft, Inc.	Orange, Illinois
82647	Metals and Controls, Inc., Div. Texas Instruments, Spencer Products	Attleboro, Mass.
82866	Research Products Corp.	Madison, Wisc.
82877	Barnes Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif
83053	Western Washer Mfr. Co.	Los Angeles, California
83058	Carr Fastener Co.	Cambridge, Mass
83086	New Hampshire Ball Bearing	Peterborough, N.H.
83125	Pyramid Electric Co.	Darlington, S.C.
83148	Electro Cords Co.	Los Angeles, Calif
83186	Victory Engineering Corp.	Springfield, N.J.
83298	Bendix Corp, Red Bank Div.	Red Bank, N.J.
83345	Hubbell Corp.	Muntelaun, Illinois
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83385	Control Screw Co	Chicago, Illinois
83501	Gavitt Wire and Cable Co., Div. Amerace Corp.	Brookfield, Mass
83594	Burroughs Corp., Electronic Tube Div	Plainfield, N.J.

Code No.	Manufacturer	Address
83740	Eveready Battery	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
84171	Arco Electronics, Inc	New York, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	Good All Electric Mfg. Co.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc	Bloomington, Ind
85454	Boonton Molding Co.	Boonton, N.J.
85474	R M. Bescomonte and Co.	San Francisco, Calif.
85660	Rotted Kunig, Inc.	New Haven, Conn.
85911	Seamless Rubber Co.	Chicago, Illinois
86197	Clifton Precision Products	Clifton Heights, Pa.
86379	Precision Rubber Products Corp.	Dayton Ohio
86684	Radio Corp. of America, RCA Electron Tube Div	Harrison, N.J.
87216	Philco Corp. (Lansing Div.)	Lansing, Pa.
87473	Western Fibrous Glass Products Co	San Francisco
87664	Van Waters and Rogers, Inc.	Seattle, Wash.
87930	Tower Mfg. Co.	Providence, R.I.
88160	Cutler-Hammer, Inc.	Lincoln, Illinois
88420	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89462	Walden Kohnnor, Inc	Cambridge, Mass.
89473	General Electric Distributing Corp	Schenectady, N.Y.
89636	Carter Parts Div. of Economy Baker Co.	Chicago, Illinois
89665	United Transformer Co.	Chicago, Illinois
90179	U.S. Rubber Co., Mechanical Goods Div.	Passaic, N.J.
90970	Bearing Engineering Co	San Francisco, Calif.
91260	Connor Spring Mfg. Co	San Francisco, Calif.
91345	Miller Dial and Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Illinois
91506	August Brothers, Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Neb.
91662	Elco Corp.	Philadelphia
91737	Gremar Mfg Co., Inc.	Wakefield Mass.
91929	Minneapolis-Honeywell Regulator Co., Microswitch Div.	Freeport, Illinois
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92196	Universal Metal Prod., Inc.	Bassett Puente, Calif.
92367	Elgeet Optical Co., Inc.	Rochester, N.Y.
92637	Tinsolite Insulated Wire Co.	Tarrytown, N.Y.
93332	Sylvania Electric Prod, Inc. Semiconductor Div.	Woburn, Mass
93369	Robbins and Myers Inc.	New York, N.Y.
93490	Stevens Mfg. Co., Inc.	Mansfield, Ohio
93588	Howard J. Smith, Inc	Port Monmouth, N.J.
93929	G.V. Controls	Livingston, N.J.
93983	Insuline-Van Norman Ind , Inc. Electronic Division	Manchester, N.H.
94137	General Cable Corp.	Bayonne, N.J.
94144	Raytheon Mfg. Co., Industrial Comp. Div, Rec. Tube Div.	Quincy, Mass.
94145	Raytheon Mfg. Co., Semiconductor Div, Calif. St. Plt	Newton, Mass.
94148	Scientific Radio Products	Loveland, Colo.
94154	Tung-Sol Electric, Inc.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	E. Paterson, N.J.
94222	Southco, Div. S. Chester Corp.	Lester, Pa.
94310	Tru Ohm Prod., Div. Model Engineering and Mfg Co.	Chicago, Illinois
94330	Wire Cloth Products, Inc.	Chicago, Illinois
94682	Worcester Pressed Alum. Corp.	Worcester, Mass.
95023	Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp	Miami, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc	New York, N.Y.
95264	Larco Electronics, Inc.	Burbank, Calif
95265	National Coil Co.	Sheridan, Wyo
95275	Vitramon, Inc.	Bridgeport, Conn
95348	Gordos Corp.	Thomaston, N.J.
95754	Methode Mfg. Co.	Chicago, Illinois
95712	Dage Electric Co., Inc.	Franklin, Ind.
95987	Weckesser Co	Chicago, Illinois
96067	Huggins Laboratories	Sunnyvale, Calif.
96095	M-Q Div. of Aerovox	Olean, N.Y.
96256	Thordarson-Meissner, Div. Maguire Industries, Inc	Mt. Carmel, Ill.
96296	Solar Manufacturing Co	Los Angeles, Calif.
96330	Carlton Screw Co	Chicago, Illinois
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co	Oakland, Calif.
97464	Industrial Retaining Ring Co.	Irvington, N.J
97539	Automatic and Precision Mfg.	Yonkers, N.Y.
97900	CBS Electronics Div. C.B.S., Inc.	Danvers, Mass.
97979	Ruon Resistor Corp.	Yonkers, N.Y.
98141	Ace Brothers, Inc.	Jamaica, N.Y.
98159	Rubber Tech, Inc.	Gardena, Calif
98220	Francis L. Mosley	Pasadena, Calif.
98278	Microdot, Inc.	S. Pasadena, Calif.
98291	Spaloetto Corp.	Mamaroneck, N.Y.
98465	Corad Corp.	Redwood City, Calif.
98731	General Mills	Minneapolis, Minn.
98821	North Hills Electric Co	Mineola, N.Y.
98925	Clevite Transistor Prod Div. Clevite Corp	Waltham, Mass
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif
99515	Marshall Industries, Electron Products Division	Pasadena, Calif
99707	Control Switch Div. Controls Co of America	El Segundo, Calif
99800	Delevan Electronics Corp	E. Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind
99934	Renbrandt, Inc	Boston, Mass
99942	Hoffman Semiconductor Div. of Hoffman Electronics Corp.	Evanston, Illinois
99957	Technology Instrument Corp of California	Newbury Park, Calif.

PART	DESCRIPTION	EXACT NO	MFG
C2120	CAPACITOR, 2522MFD 35V	2900834	853
C2121	CAPACITOR, 100PF MICA	2810537	853
C2125	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100222
C2135	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2140	CAPACITOR, 2522MFD 35V	2900834	853
C2141	CAPACITOR, 272PF MICA	2810542	853
C2155	CAPACITOR, 0.05 UF DISCAP	2837017	91418
C2160	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100222
C2175	CAPACITOR, 0.05 UF DISCAP	2837017	91418
C2176	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2235	CAPACITOR, 1000 PF DISCAP	2832003	91418
C2242	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2241	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2243	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2265	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2266	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2275	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2276	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2320	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2321	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2311	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2345	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2360	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2405	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2410	CAPACITOR, SELECTED VALUE		
C2420	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2421	CAPACITOR, 3.5-18PF TRIM	2812011	72982
C2422	CAPACITOR, 7PF MICA	2810536	853
C2423	CAPACITOR, 39PF MICA	2812531	853
C2424	CAPACITOR, TIMING SET	2952024	10597
C2425	CAPACITOR, SELECTED VALUE		
C2435	CAPACITOR, 18PF MICA	2810552	14655
C2445	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2446	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2447	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2448	CAPACITOR, 5222 PF DISCAP	2832011	91418
C2451	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2452	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2455	CAPACITOR, 182PF MICA	2810554	853
C2456	CAPACITOR, 5.5-18PF TRIM	2812011	72982
C2457	CAPACITOR, 47PF MICA	2812532	853
C2462	CAPACITOR, 7PF MICA	2812536	853
C2465	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2465	CAPACITOR, SELECTED VALUE		
C2467	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2471	CAPACITOR, 222PF MICA	2810555	853
C2475	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2476	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2481	CAPACITOR, 0.05 UF DISCAP	2832010	91418
L2482	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2483	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2486	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2487	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2488	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2629	CAPACITOR, 82PF MICA	2812533	853
C2722	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2727	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2728	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2715	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C2722	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2725	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C2726	CAPACITOR, 5.5-18PF TRIM	2812011	72982
C2727	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2731	CAPACITOR, 1000 PF DISCAP	2832000	91418
C2735	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C2737	CAPACITOR, 1000 PF DISCAP	2832000	91418
C2742	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2741	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2745	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2746	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2751	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2756	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2760	CAPACITOR, 0.47MFD 75V	2922050	56289
C2761	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2763	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2782	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2785	CAPACITOR, 0.01 UF DISCAP	2832005	91418
C2787	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2791	CAPACITOR, 1000 PF DISCAP	2832000	91418
C2795	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2797	CAPACITOR, 1000 PF DISCAP	2832000	91418
C2802	CAPACITOR, 392PF MICA	2810556	853
C2821	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2825	CAPACITOR, 392PF MICA	2812556	853
C2826	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2811	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2816	CAPACITOR, 6.8 MFD 35 VOLT	2922043	100822
C2817	CAPACITOR, 0.05 UF DISCAP	2832012	91418
C2832	CAPACITOR, 0.05 UF DISCAP	2832010	91418
C2831	CAPACITOR, 102PF MICA	2812533	853
C2835	CAPACITOR, 3PF MICA	2810500	853
C2837	CAPACITOR, 5222 PF DISCAP	2832011	91418
C2842	CAPACITOR, 5222 PF DISCAP	2832011	91418
C2845	CAPACITOR, 5222 PF DISCAP	2832011	91418
C2852	CAPACITOR, 82PF MICA	2812533	853
C2851	CAPACITOR, 22PF MICA	2812532	853
C2862	CAPACITOR, 7PF MICA.	2812536	853
D2122	RECTIFIER BRIDGE, MDA920A-3	1522920	4713
D2125	DIODE, 1N4001	1524001	1295
D2135	DIODE, 1N4001	1524001	1295
D2162	DIODE, 1N914	1520914	7910
D2161	DIODE, 1N4001	1524001	1295
D2165	DIODE, 1N757	1520757	1295
D2175	DIODE, 1N4001	1524001	1295
D2417	DIODE, HOT CARRIER	1522835	10597
D2411	DIODE, CD1541	1521541	14655
D2412	DIODE, CD1541	1521541	14655
D2413	DIODE, HOT CARRIER	1522835	10597

PART	DESCRIPTION	EXACT NO	MFG
D2425	DIODE, HOT CARRIER	1522835	10597
D2426	DIODE, CD1541	1521541	14655
D2427	DIODE, CD1541	1521541	14655
D2428	DIODE, HOT CARRIER	1522835	10597
D2451	TO		
D2454	DIODE, 1N914	1520914	7910
D2460	TO		
D2463	DIODE, HOT CARRIER	1522835	10597
D2464	DIODE, HOT CARRIER	1522835	10597
D2465	DIODE, 1N914	1520914	7910
D2466	DIODE, 1N914	1520914	7910
D2467	DIODE, HOT CARRIER	1522835	10597
D2468	DIODE, 1N914	1520914	7910
D2469	DIODE, 1N914	1520914	7910
D2470	DIODE, HOT CARRIER	1522835	10597
D2471	DIODE, HOT CARRIER	1522835	10597
D2481	DIODE, 1N914	1520914	7910
D2482	DIODE, 1N914	1520914	7910
D2600	DIODES, MATCHED 2835	1532835	10597
D2604	DIODES, MATCHED 2835	1532835	10597
D2628	DIODES, MATCHED 2835	1532835	10597
D2612	DIODES, MATCHED 2835	1532835	10597
D2682	DIODE, 1N749	1520749	1295
D2740	DIODE, 1N914	1520914	7910
D2741	DIODE, 1N914	1520914	7910
D2742	DIODE, 1N914	1520914	7910
D2745	DIODE, 1N914	1520914	7910
D2746	DIODE, 1N914	1520914	7910
D2747	DIODE, 1N914	1520914	7910
D2751	DIODE, 1N753A	1520753	1295
D2756	DIODE, 1N753A	1520753	1295
D2800	DIODE, 1N914	1520914	7910
D2821	DIODE, 1N914	1520914	7910
D2832	DIODE, 1N914	1520914	7910
D2823	DIODE, 1N914	1520914	7910
D2824	DIODE, 1N914	1520914	7910
D2825	DIODE, 1N914	1520914	7910
D2826	DIODE, 1N914	1520914	7910
D2827	DIODE, 1N914	1520914	7910
D2835	DIODE, CD1541	1521541	14655
D2836	DIODE, CD1541	1521541	14655
D2837	DIODE, 1N914	1520914	7910
D2838	DIODE, 1N751A	1520751	75042
D2845	DIODE, 1N753A	1520753	1295
D2852	DIODE, 1N914	1520914	7910
D2851	DIODE, 1N914	1520914	7910
D2852	DIODE, 1N914	1520914	7910
D2853	DIODE, HOT CARRIER	1522835	10597
D2854	DIODE, 1N914	1520914	7910
D2855	DIODE, HOT CARRIER	1522835	10597
D2857	DIODE, 1N757	1520757	1295
F0100	FUSE, 3AG 1/2 AMP SLO BLO	1592024	71400
I0120	LAMP, #2187	1520019	71744
J0122	BINDING POST, BLACK	3552536	10597
J0121	BINDING POST, WHITE	3552535	10597
J0240	CONNECTOR, BNC	1312047	91836
J0452	CONNECTOR, BNC	1312047	91836
J0492	CONNECTOR, BNC	1312047	91836
J0820	CONNECTOR, BNC	1312047	91836
J0842	CONNECTOR, BNC	1312047	91836
L0140	BEAD, FERRITE G303	1140034	1121
L0447	BEAD, FERRITE G303	1140034	1121
L2460	BEAD, FERRITE G303	1140034	1121
L2461	BEAD, FERRITE G303	1140034	1121
L2465	BEAD, FERRITE G303	1140034	1121
L0822	BEAD, FERRITE G303	1140034	1121
L0835	BEAD, FERRITE G303	1140034	1121
Q0120	INTEGRATED CIRCUIT, UA723	1582212	7263
Q0125	TRANSISTOR, 2N4910	1564910	4713
Q2130	INTEGRATED CIRCUIT, UA723	1582812	7263
Q2135	TRANSISTOR, 2N4910	1564910	4713
Q0140	TRANSISTOR, TIS87	1562087	1295
Q0145	TRANSISTOR, 2N4898	1564898	4713
Q0150	TRANSISTOR, 2N4121	1564121	7263
Q0155	TRANSISTOR, 2N4121	1564121	7263
Q0160	TRANSISTOR, EN2484	1562484	7263
Q0165	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q0170	TRANSISTOR, 2N2905	1562905	1295
Q0175	TRANSISTOR, 2N4898	1564898	4713
Q0180	TRANSISTOR, EN2484	1562484	7263
Q0235	TRANSISTOR, 2N2905	1562905	1295
Q0242	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q0265	OPERATIONAL AMPLIFIER, UA741	1587810	7263
Q0272	TRANSISTOR, 2N5245	1565245	1295
Q0275	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q0280	TRANSISTOR, 2N5462	1565462	4713
Q0320	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q0310	TRANSISTOR, 2N2219	1562219	1295
Q0402	TRANSISTOR, UC2138	1562138	61637
Q0425	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q0410	TRANSISTOR, UC420	1567420	17856
Q0415	TRANSISTOR, UC2138	1562138	61637
Q0422	OPERATIONAL AMPLIFIER, UA741	1582810	7263
Q2425	TRANSISTOR, 2N4416	1564416	4713
Q0435	TRANSISTOR, DN991	1562991	10597
Q2442	TRANSISTORS, MATCHED TIS87	1572087	10597
Q0445	TRANSISTOR, MATCHED 2N3866	1573866	10597
Q2462	TRANSISTORS, MATCHED TIS87	1572087	10597
Q0465	TRANSISTOR, 2N2219	1562219	1295
Q0472	TRANSISTOR, 2N4258	1564258	7263
Q0475	TRANSISTOR, 2N4258	1564258	7263
Q0492	TRANSISTOR, MPS3563	1563563	4713
Q0495	TRANSISTOR, 2N4121	1564121	7263
Q0702	TRANSISTOR, 2N4245	1564245	7263
Q2712	TRANSISTOR, EN2484	1562484	7263
Q2715	TRANSISTOR, EN2484	1562484	7263
Q2722	TRANSISTOR, 2N4258	1564258	7263
Q2725	TRANSISTOR, MPS3563	1563563	4713

PART	DESCRIPTION	EXACT NO	MFG
Q2732	TRANSISTOR, 2N2905	1562905	1295
Q2735	TRANSISTOR, 2N2219	1562219	1295
Q2742	TRANSISTOR, MPS3563	1563563	4713
Q2745	TRANSISTOR, 2N4258	1564258	7263
Q2752	TRANSISTOR, MPS3563	1563563	4713
Q2755	TRANSISTOR, 2N4258	1564258	7263
Q2762	TRANSISTOR, 2N4245	1564245	7263
Q2770	TRANSISTOR, 2N2484	1562484	7263
Q2775	TRANSISTOR, 2N2484	1562484	7263
Q2780	TRANSISTOR, 2N4258	1564258	7263
Q2785	TRANSISTOR, MPS3646	1563646	4713
Q2792	TRANSISTOR, 2N2905	1562905	1295
Q2795	TRANSISTOR, 2N2219	1562219	1295
Q2802	TRANSISTOR, TIS87	1560287	1295
Q2825	TRANSISTOR, 2N4121	1564121	7263
Q2810	TRANSISTOR, 2N2219	1562219	1295
Q2815	TRANSISTOR, 2N2905	1562905	1295
Q2832	TRANSISTORS, MATCHED 2N4258	1574258	10597
Q2835	TRANSISTOR, TIS87	1562287	1295
Q2842	TRANSISTOR, MPS3563	1563563	4713
Q2845	TRANSISTOR, 2N4258	1564258	7263
Q2852	TRANSISTOR, TIS87	1562287	1295
Q2862	TRANSISTOR, TIS87	1562287	1295
R2120	RESISTOR, 2202 OHM 1/4W 5% CARBON	3272222	1121
R2125	RESISTOR, 2.5 OHM WIREWOUND	3282225	75242
R2126	RESISTOR, 7870 OHM 1/4W 1% METAL FILM	3137871	7115
R2127	POTENTIOMETER, 1K OHM TRIM	3112147	71452
R2128	RESISTOR, 3210 OHM 1/4W 1% METAL FILM	3133211	7115
R2132	RESISTOR, 1602 OHM 1/4W 5% CARBON	3272162	1121
R2135	RESISTOR, 1.2 OHM 1/2W 5% CARBON	3212010	1121
R2136	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R2137	POTENTIOMETER, 1K OHM TRIM	3112147	71452
R2138	RESISTOR, 3210 OHM 1/4W 1% METAL FILM	3133211	7115
R2142	RESISTOR, 1602 OHM 1/4W 5% CARBON	3272162	1121
R2141	RESISTOR, 18K OHM 1/4W 5% CARBON	3273183	1121
R2142	RESISTOR, 120 OHM 1/4W 5% CARBON	3271201	1121
R2145	RESISTOR, 122 OHM 1/4W 5% CARBON	3271221	1121
R2146	RESISTOR, 0.5 OHM WIREWOUND	3282275	75242
R2152	RESISTOR, 5102 OHM 1/4W 5% CARBON	3275125	1121
R2151	RESISTOR, 13K OHM 1/4W 5% CARBON	3273133	1121
R2155	RESISTOR, 7502 OHM 1/4W 5% CARBON	3275752	1121
R215A	RESISTOR, 12222 OHM 1/4W 1% METAL FILM	3131222	7115
R2157	POTENTIOMETER, 500 OHM TRIM	3112142	71452
R2158	RESISTOR, 12222 OHM 1/4W 1% METAL FILM	3131222	7115
R2161	RESISTOR, 13K OHM 1/4W 5% CARBON	3273133	1121
R2165	RESISTOR, 15222 OHM 1/4W 1% METAL FILM	3131522	7115
R2166	POTENTIOMETER, 500 OHM TRIM	3112142	71452
R2167	RESISTOR, 15222 OHM 1/4W 1% METAL FILM	3131522	7115
R2168	RESISTOR, 7502 OHM 1/4W 5% CARBON	3275752	1121
R2172	RESISTOR, 1202 OHM 1/4W 5% CARBON	3271202	1121
R2173	RESISTOR, 10K OHM 1/4W 5% CARBON	3273103	1121
R2175	RESISTOR, 0.5 OHM WIREWOUND	3282275	75242
R2235	RESISTOR, 622 OHM 1/4W 5% CARBON	3272621	1121
R223A	RESISTOR, 124K OHM 1/4W 1% METAL FILM	3131243	7115
R2237	RESISTOR, 1302 OHM 1/4W 5% CARBON	3271321	1121
R2242	RESISTOR, 49902 OHM 1/4W 1% METAL FILM	3134992	7115
R2242	RESISTOR, 120202 OHM 1/4W 5% CARBON	3272126	1121
R2243	POTENTIOMETER, 15K OHM TRIM	3112150	71452
R2245	RESISTOR, 22K OHM 1/4W 5% CARBON	3272223	1121
R2246	POTENTIOMETER, 12K OHM TRIM	3112152	71452
R2247	RESISTOR, 124K OHM 1/4W 1% METAL FILM	3131243	7115
R2265	POTENTIOMETER, 17K OHM TRIM	3112150	71452
R2266	RESISTOR, 1202 OHM 1/4W 5% CARBON	3271202	1121
R2267	RESISTOR, SELECTED VALUE		
R2268	POTENTIOMETER, 20K/20K DUAL	3110336	12502
R2269	RESISTOR, 1202 OHM MATCHED PAIR	3121021	12597
R2275	POTENTIOMETER, 12K OHM TRIM	3112152	71452
R2276	RESISTOR, 1202 OHM MATCHED PAIR	3121221	12597
R2278	RESISTOR, SELECTED VALUE		
R2321	RESISTOR, 5102 OHM 1/4W 5% CARBON	3275125	1121
R2324	RESISTOR, 71502 OHM 1/4W 1% METAL FILM	3137152	7115
R2325	POTENTIOMETER, 17K OHM TRIM	3112150	71452
R2326	RESISTOR, 10002 OHM 1/4W 1% METAL FILM	3131022	7115
R2332	RESISTOR, 1322 OHM 1/4W 5% CARBON	3271321	1121
R2311	RESISTOR, 622 OHM 1/4W 5% CARBON	3272621	1121
R2312	CONCENTRIC SWITCH & POTENTIOMETER	2622313	71452
R2313	RESISTOR, SELECTED VALUE		
R2314	TO		
R2325	RESISTOR, 102 OHM 1/8W 1% METAL FILM	3101002	7115
R2422	RESISTOR, 51.2 OHM 1/4W 5% CARBON	3275129	1121
R2421	RESISTOR, 22 OHM 1/4W 5% CARBON	3272201	1121
R2422	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R2423	POTENTIOMETER, 12K OHM TRIM	3112152	71452
R2424	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R2425	RESISTOR, 1202 OHM MATCHED PAIR	3121021	12597
R2426	RESISTOR, 12002 OHM MATCHED PAIR	3121222	12597
R2427	RESISTOR, 122K OHM MATCHED PAIR	3121223	12597
R2428	RESISTOR, 1202K OHM MATCHED PAIR	3121024	12597
R2429	RESISTOR, 12022K OHM MATCHED PAIR	3121025	12597
R2412	RESISTOR, 102 OHM 1/4W 5% CARBON	3272121	1121
R2415	RESISTOR, 5102 OHM 1/4W 5% CARBON	3275125	1121
R2417	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R2418	POTENTIOMETER, 17K OHM TRIM	3112152	71452
R2419	RESISTOR, 274K OHM 1/4W 1% METAL FILM	3132743	7115
R2425	RESISTOR, 102 OHM 1/4W 5% CARBON	3272121	1121
R2431	RESISTOR, 272 OHM 1/4W 5% CARBON	3272721	1121
R2435	RESISTOR, 51.0 OHM 1/4W 5% CARBON	3275121	1121
R2442	RESISTOR, 752 OHM 1/4W 5% CARBON	3275751	1121
R2441	RESISTOR, 150 OHM 1/4W 5% CARBON	3271521	1121
R2445	RESISTOR, 220 OHM 1/2W 5% CARBON	3212221	1121
R2452	RESISTOR, 752 OHM 1/4W 5% CARBON	3272751	1121
R2451	RESISTOR, 12K OHM 1/4W 5% CARBON	3273123	1121
R2452	RESISTOR, 12K OHM 1/4W 5% CARBON	3273123	1121
R2455	RESISTOR, 383 OHM 1/2W 1% METAL FILM	3123832	7115
R2457	RESISTOR, 12K OHM 1/4W 5% CARBON	3273123	1121
R2458	RESISTOR, 365 OHM 1/4W 1% METAL FILM	3133652	7115
R2459	RESISTOR, 365 OHM 1/4W 1% METAL FILM	3133652	7115
R2462	RESISTOR, 102 OHM 1/4W 1% METAL FILM	3131022	7115

PART	DESCRIPTION	EXACT NO	MFG
R2461	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R2462	RESISTOR, 2492 OHM 1/4W 1% METAL FILM	3132491	7115
R2463	RESISTOR, 2492 OHM 1/4W 1% METAL FILM	3132491	7115
R2464	POTENTIOMETER, 500 OHM TRIM	3112142	71452
R2465	RESISTOR, 1582 OHM 1/4W 1% METAL FILM	3131581	7115
R2466	RESISTOR, 10202 OHM 1/4W 1% METAL FILM	3131022	7115
R2467	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115
R2469	RESISTOR, 822 OHM 1/2W 5% CARBON	3212821	1121
R2472	RESISTOR, 221 OHM 1/2W 1% METAL FILM	3122210	7115
R2471	RESISTOR, 3320 OHM 1/4W 1% METAL FILM	3133321	7115
R2475	RESISTOR, 3322 OHM 1/4W 1% METAL FILM	3133321	7115
R2476	RESISTOR, 22 OHM 1/4W 5% CARBON	3272220	1121
R2482	RESISTOR, 4702 OHM 1/4W 5% CARBON	3274722	1121
R2481	RESISTOR, 152 OHM 1/4W 5% CARBON	3271521	1121
R2485	RESISTOR, 4702 OHM 1/4W 5% CARBON	3274722	1121
R2486	RESISTOR, 152 OHM 1/4W 5% CARBON	3271521	1121
R2491	RESISTOR, 22 OHM 1/4W 5% CARBON	3272220	1121
R2494	RESISTOR, 102 OHM 1/4W 5% CARBON	3271021	1121
R2496	RESISTOR, 22 OHM 1/4W 5% CARBON	3272220	1121
R2624	RESISTOR, 49.9 OHM 1/4W 1% METAL FILM	3134999	7115
R2625	RESISTOR, 202 OHM 1/4W 1% METAL FILM	3132020	7115
R2626	RESISTOR, 122 OHM 1/4W 1% METAL FILM	3131220	7115
R2627	RESISTOR, 124 OHM 1/4W 1% METAL FILM	3131240	7115
R2628	RESISTOR, 47 OHM 1/4W 5% CARBON	3274722	1121
R2615	POTENTIOMETER, 1K OHM TRIM	3112147	71450
R2616	POTENTIOMETER, 1K OHM TRIM	3112147	71452
R2617	RESISTOR, 75.2 OHM 1/4W 1% METAL FILM	3132752	7115
R2618	RESISTOR, 63.4 OHM 1/4W 1% METAL FILM	3132634	7115
R2619	RESISTOR, 12002 OHM 1/4W 1% METAL FILM	3131202	7115
R2622	RESISTOR, 232 OHM 1/4W 1% METAL FILM	3132320	7115
R2621	RESISTOR, 12202 OHM 1/4W 1% METAL FILM	3131222	7115
R2623	RESISTOR, 32102 OHM 1/4W 1% METAL FILM	3132122	7115
R2624	POTENTIOMETER, 122 OHM TRIM	3112141	71452
R2627	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3182287	7115
R2628	RESISTOR, 32102 OHM 1/4W 1% METAL FILM	3133212	7115
R2631	POTENTIOMETER, 1K OHM TRIM	3112147	71452
R2635	POTENTIOMETER, 1K OHM TRIM	3112147	71452
R2637	RESISTOR, 28.7 OHM 1/8W 1% METAL FILM	3182287	7115
R2645	RESISTOR, 11322 OHM 1/4W 1% METAL FILM	3131132	7115
R2646	RESISTOR, 113.2 OHM 1/4W 1% METAL FILM	3131132	7115
R2647	RESISTOR, 6810 OHM 1/4W 1% METAL FILM	3136811	7115
R2648	RESISTOR, 6810 OHM 1/4W 1% METAL FILM	3136811	7115
R2720	RESISTOR, 14342 OHM 1/4W 1% METAL FILM	3131432	7115
R2721	RESISTOR, 1202 OHM 1/4W 5% CARBON	3271202	1121
R2722	RESISTOR, 15 OHM 1/4W 5% CARBON	3270150	1121
R2723	RESISTOR, 22202 OHM 1/4W 1% METAL FILM	3132222	7115
R2724	RESISTOR, 2202 OHM 1/4W 1% METAL FILM	3132022	7115
R2725	RESISTOR, 1522 OHM 1/4W 1% METAL FILM	3131521	7115
R2726	RESISTOR, 2424 OHM 1/4W 1% METAL FILM	3132423	7115
R2727	POTENTIOMETER, 10K OHM TRIM	3112152	71452
R2728	POTENTIOMETER, 252 OHM	3112145	71452
R2729	RESISTOR, 1372 OHM 1/4W 1% METAL FILM	3131371	7115
R2730	RESISTOR, 3312 OHM 1/4W 1% METAL FILM	3133311	7115
R2731	RESISTOR, 102 OHM 1/4W 5% CARBON	3271021	1121
R2732	RESISTOR, 1202 OHM 1/4W 5% CARBON	3271202	1121
R2733	RESISTOR, 1222 OHM 1/4W 1% METAL FILM	3131221	7115
R2734	RESISTOR, 4222 OHM 1/4W 1% METAL FILM	3134221	7115
R2735	RESISTOR, 5492 OHM 1/4W 1% METAL FILM	3135491	7115
R2736	RESISTOR, 4222 OHM 1/4W 1% METAL FILM	3134221	7115
R2737	RESISTOR, 51 OHM 1/4W 5% CARBON	3275109	1121
R2742	RESISTOR, 27 OHM 1/4W 5% CARBON	3272273	1121
R2741	RESISTOR, 122 OHM 1/4W 5% CARBON	3271221	1121
R2745	RESISTOR, 27 OHM 1/4W 5% CARBON	3272273	1121
R2746	RESISTOR, 47 OHM 1/4W 5% CARBON	3272473	1121
R2752	RESISTOR, 10 OHM 1/4W 5% CARBON	3271103	1121
R2755	RESISTOR, 10 OHM 1/4W 5% CARBON	3271103	1121
R2757	RESISTOR, 321 OHM 1/4W 1% METAL FILM	3133210	7115
R2758	RESISTOR, 321 OHM 1/4W 1% METAL FILM	3133210	7115
R2759	RESISTOR, 4.7 OHM 1/4W 5% CARBON	3270247	1121
R2760	RESISTOR, 24902 OHM 1/4W 1% METAL FILM	3132492	7115
R2761	RESISTOR, 1022 OHM 1/4W 5% CARBON	3271022	1121
R2762	RESISTOR, 47 OHM 1/4W 5% CARBON	3272473	1121
R2763	RESISTOR, 42202 OHM 1/4W 1% METAL FILM	3134222	7115
R2764	RESISTOR, 42202 OHM 1/4W 1% METAL FILM	3134222	7115
R2765	RESISTOR, 1522 OHM 1/4W 1% METAL FILM	3131521	7115
R2766	RESISTOR, 2282 OHM 1/4W 1% METAL FILM	3132283	7115
R2767	POTENTIOMETER, 12K OHM TRIM	3112152	71452
R2772	RESISTOR, 3212 OHM 1/4W 1% METAL FILM	3133211	7115
R2775	RESISTOR, 1272 OHM 1/4W 5% CARBON	3271272	1121
R2782	RESISTOR, 51 OHM 1/4W 5% CARBON	3275109	1121
R2781	RESISTOR, 47 OHM 1/4W 5% CARBON	3272473	1121
R2782	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R2785	RESISTOR, 3312 OHM 1/4W 1% METAL FILM	3133311	7115
R2786	RESISTOR, 51 OHM 1/4W 5% CARBON	3275109	1121
R2787	RESISTOR, 68 OHM 1/4W 5% CARBON	3276809	1121
R2788	RESISTOR, 249 OHM 1/4W 1% METAL FILM	3132490	7115
R2792	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138062	7115
R2791	RESISTOR, 12 OHM 1/4W 5% CARBON	3270120	1121
R2795	RESISTOR, 6192 OHM 1/4W 1% METAL FILM	3136191	7115
R2798	RESISTOR, SELECTED VALUE		
R2796	RESISTOR, 806 OHM 1/4W 1% METAL FILM	3138062	7115
R2797	RESISTOR, 12 OHM 1/4W 5% CARBON	3270120	1121
R2822	RESISTOR, 27 OHM 1/4W 5% CARBON	3272273	1121
R2801	RESISTOR, 68 OHM 1/4W 5% CARBON	3276809	1121
R2815	RESISTOR, 27 OHM 1/4W 5% CARBON	3272273	1121
R2812	RESISTOR, 15 OHM 1/4W 5% CARBON	3271509	1121
R2811	RESISTOR, 15 OHM 1/2W 5% CARBON	3215150	1121
R2815	RESISTOR, 15 OHM 1/4W 5% CARBON	3271509	1121
R2816	RESISTOR, 15 OHM 1/2W 5% CARBON	3215150	1121
R2817	RESISTOR, 1522 OHM 1/4W 1% METAL FILM	3131521	7115

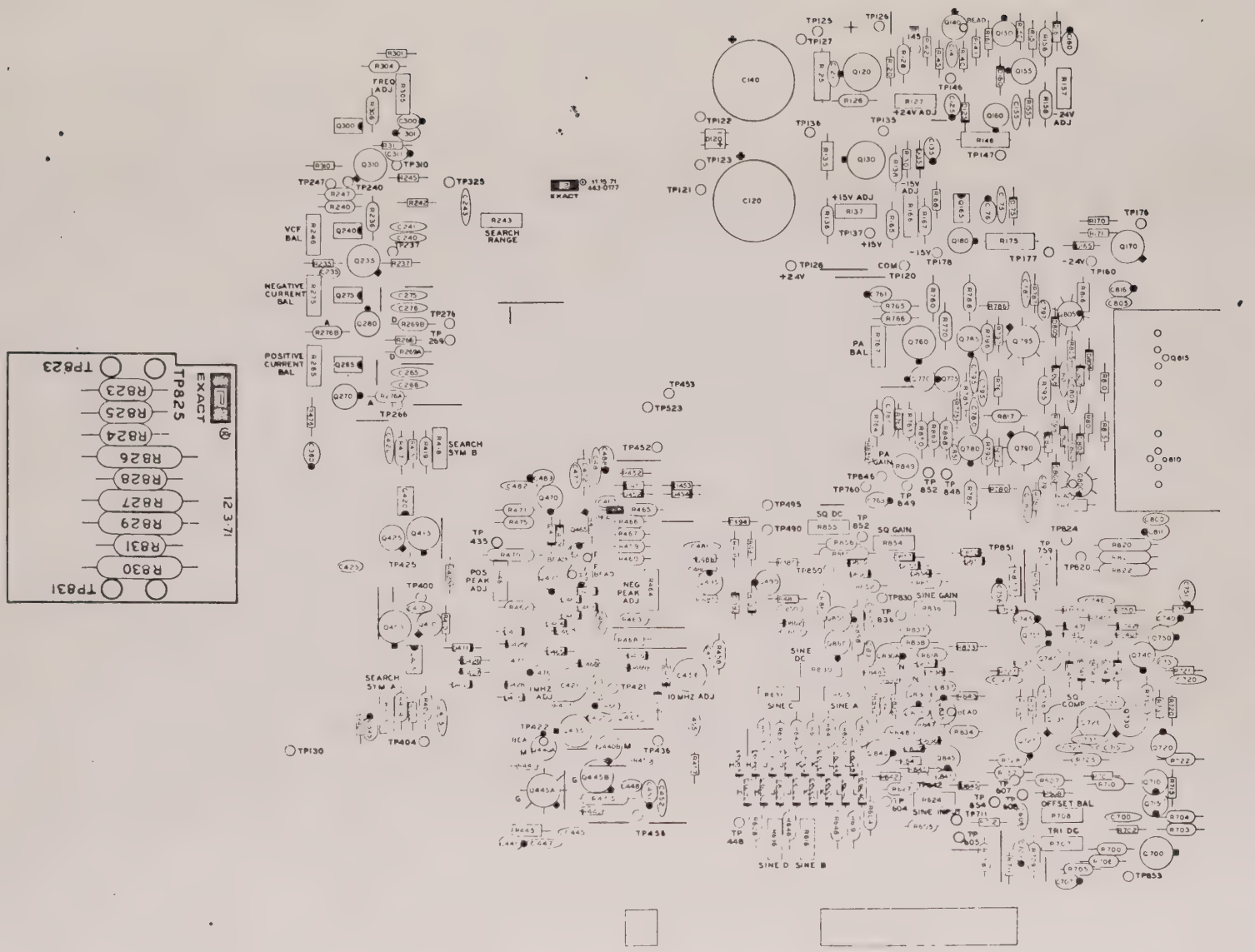
PART	DESCRIPTION	EXACT NO	MFG
R0822 TO			
R0822	RESISTOR, 150 OHM 1/2W 1% METAL FILM	3101500	7115
R0823	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3132261	7115
R0824	RESISTOR, 26.1 OHM 1/4W 1% METAL FILM	3132261	7115
R0825	RESISTOR, 34.8 OHM 1/4W 1% METAL FILM	3132348	7115
R0826	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3122412	7115
R0827	RESISTOR, 41.2 OHM 1/2W 1% METAL FILM	3122412	7115
R0828	RESISTOR, 10.2 OHM 1/8W 1% METAL FILM	3102100	7115
R0829	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3122464	7115
R0830	RESISTOR, 46.4 OHM 1/2W 1% METAL FILM	3122464	7115
R0831	RESISTOR, 3.16 OHM 1/8W 1% DEP. CARBON	3103162	7115
R0832	RESISTOR, 15 OHM 1/4W 5% CARBON	3272150	1121
R0833	RESISTOR, 1522 OHM 1/4W 5% CARBON	3272152	1121
R0834	RESISTOR, 576 OHM 1/4W 1% METAL FILM	3135760	7115
R0835	RESISTOR, 1520 OHM 1/4W 5% CARBON	3272152	1121
R0836	POTENTIOMETER, 5K OHM TRIM	3112149	71450
R0837	RESISTOR, 2210 OHM 1/4W 1% METAL FILM	3132211	7115
R0838	RESISTOR, 26120 OHM 1/4W 1% METAL FILM	3132612	7115
R0839	POTENTIOMETER, 10K OHM TRIM	3110150	71450
R0840	RESISTOR, 51 OHM 1/4W 5% CARBON	3272510	1121
R0841	RESISTOR, 10 OHM 1/4W 5% CARBON	3272100	1121
R0842	RESISTOR, 10 OHM 1/4W 5% CARBON	3272100	1121
R0843	RESISTOR, 1520 OHM 1/4W 5% CARBON	3272152	1121
R0844	RESISTOR, 15 OHM 1/4W 5% CARBON	3272150	1121
R0845	RESISTOR, 10 OHM 1/4W 5% CARBON	3272100	1121
R0846	RESISTOR, 374 OHM 1/4W 1% METAL FILM	3133742	7115
R0847	RESISTOR, 127 OHM 1/4W 1% METAL FILM	3131272	7115
R0848	RESISTOR, 750 OHM 1/4W 1% METAL FILM	3137502	7115
R0849	POTENTIOMETER, 50 OHM SLOMIN,	3117140	82294
R0850	RESISTOR, 274 OHM 1/4W 1% METAL FILM	3132740	7115
R0851	RESISTOR, 2742 OHM 1/4W 1% METAL FILM	3132741	7115
R0852	RESISTOR, 866 OHM 1/4W 1% METAL FILM	3138662	7115
R0863	RESISTOR, 1470 OHM 1/4W 1% METAL FILM	3131471	7115
R0853	POTENTIOMETER, 10K OHM	3110334	12697
R0854	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R0855	POTENTIOMETER, 500 OHM TRIM	3112142	71450
R0856	RESISTOR, 1270 OHM 1/4W 1% METAL FILM	3131271	7115
R0857	RESISTOR, 680 OHM 1/2W 5% CARBON	3206681	1121
R0858	RESISTOR, 2370 OHM 1/2W 1% METAL FILM	3122371	7115
R0859	RESISTOR, 15 OHM 1/4W 5% CARBON	3273150	1121
R0860	RESISTOR, 475 OHM 1/2W 1% METAL FILM	3124752	7115
R0861	RESISTOR, 2490 OHM 1/4W 1% METAL FILM	3132491	7115
R0862	SWITCH, ROTARY	2620344	12597
R0472	RESISTOR, 47 OHM 1/2W 5% CARBON	3204702	1121
S2100	SWITCH, TOGGLE SPDT	2602103	100005
S2101	SWITCH, SLIDE	2602319	12597
S2265	SWITCH, PUSH BUTTON	2602352	12597
S0310	CONCENTRIC SWITCH & POTENTIOMETER	2602313	71450
S2702	SWITCH, ROTARY	2602344	12597
S0705	SWITCH, PUSH BUTTON	2602351	12597
S0712	SWITCH, PUSH BUTTON	2602351	12597
S2802	SWITCH, PUSH BUTTON	2602351	12597
S0812	SWITCH, PUSH BUTTON	2602351	12597
S0822	SWITCH, PUSH BUTTON	2602351	12597
S2837	SWITCH, PUSH BUTTON	2602351	12597
T0100	TRANSFORMER, POWER	1200242	12597

SECTION 6

PARTS OVERLAY AND SCHEMATICS

FOREWORD TO SCHEMATICS

To facilitate quick reference to inter-connections from one schematic to another, a system of numbers has been utilized. Each schematic carries its own identifying number located in a large hexagonal shape near the title. When a connection is referred to, a small hex encompasses the number of the schematic that contains the connection. Use the Connection Reference Chart to locate where reference numbers are shown, but no actual schematic exists for that particular model.


TP825
EXACT
TP823
R823
R825
R824
R826
R828
R827
R829
R831
R830
TP831
12-3-71
FREQ ADJ
VCF BAL
NEGATIVE CURRENT BAL
POSITIVE CURRENT BAL
SEARCH RANGE
SEARCH SYM B
SEARCH SYM A
POS PEAK ADJ
NEG PEAK ADJ
10 MHZ ADJ
PA BAL
PA GAIN
SQ DC
SQ GAIN
SINE GAIN
SINE DC
SINE C
SINE A
SINE D
SINE B
SQ COMP
OFFSET BAL
TRI DC
+24V ADJ
-24V ADJ
+15V ADJ
-15V ADJ
COM
+24V
-15V
+15V
-24V

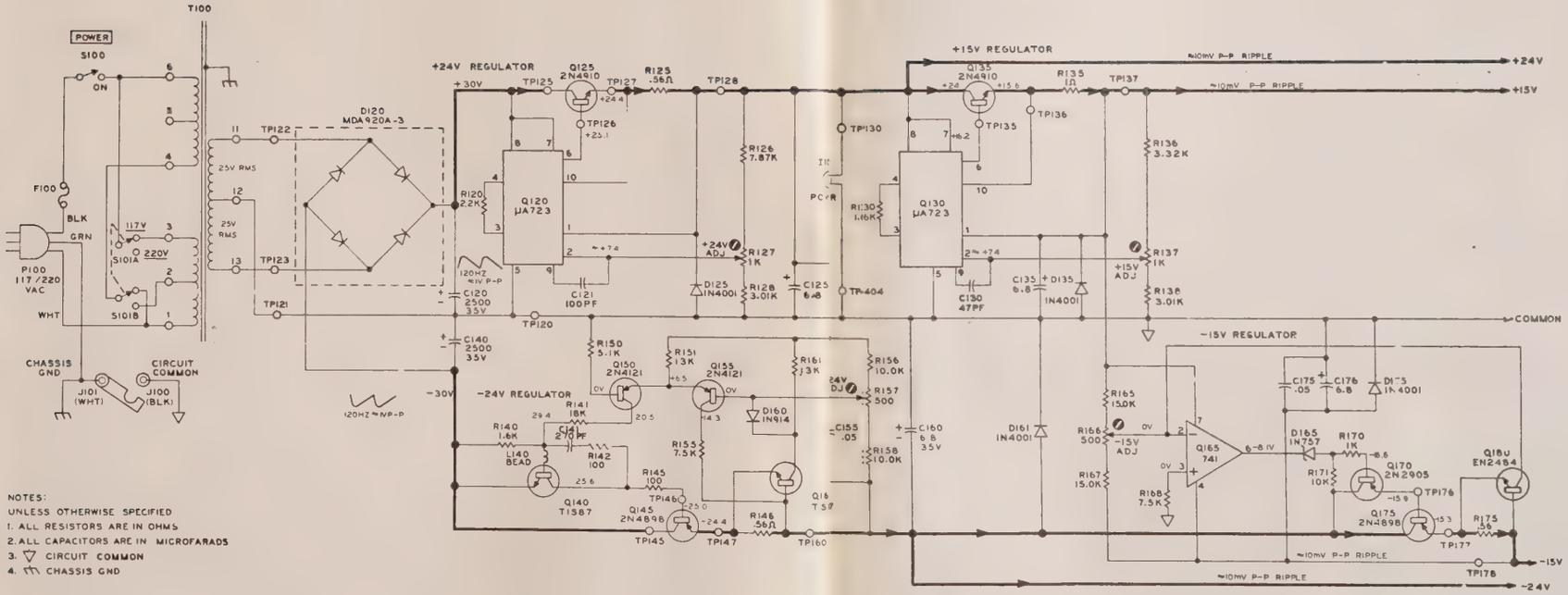
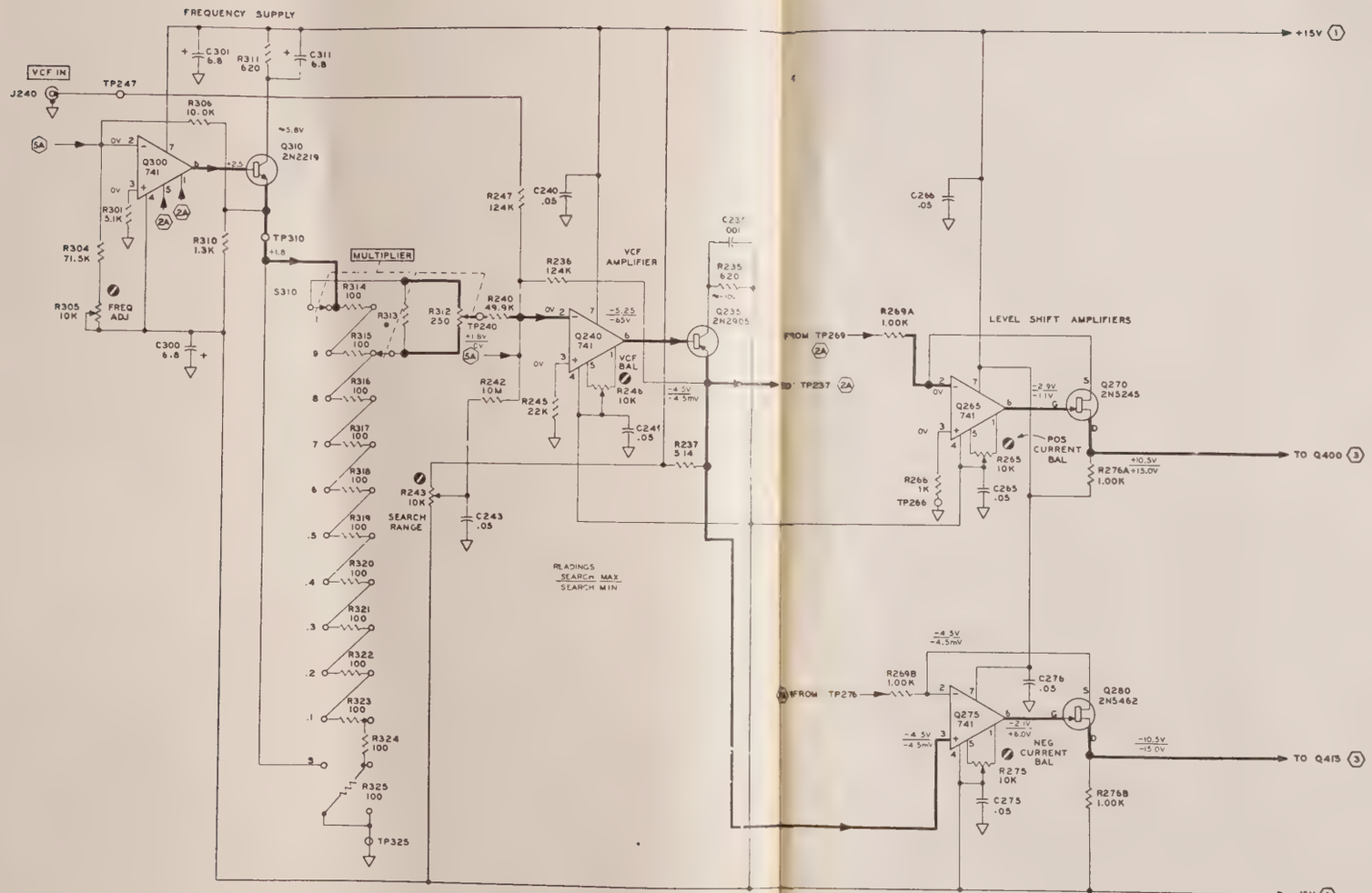
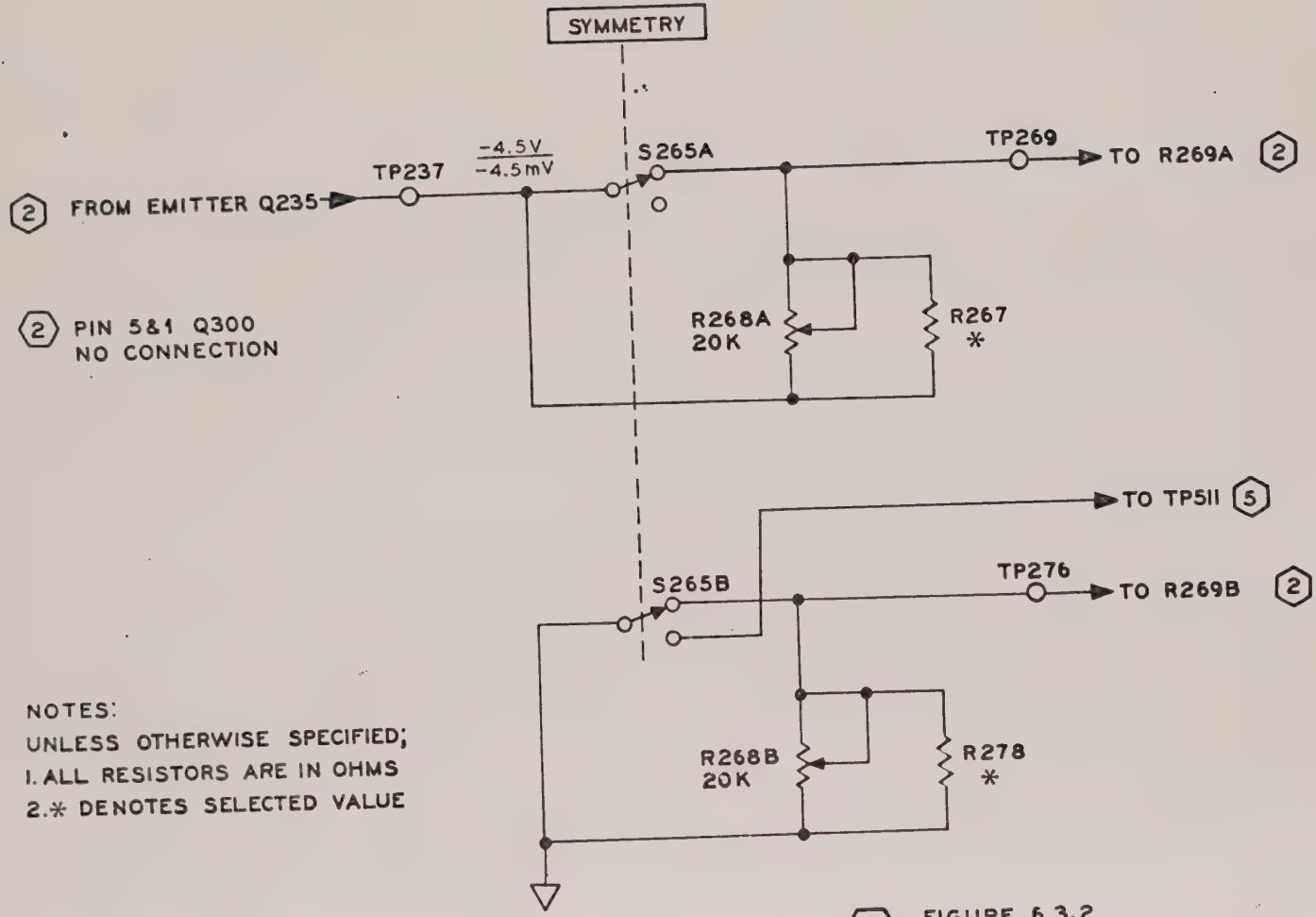


FIGURE 6.2.1
(1) SCHEMATIC DIAGRAM
POWER SUPPLY CIRCUIT



NOTES
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. ALL CAPACITORS ARE IN MICROFARADS
3. * DENOTES SELECTED VALUE

(2) FIGURE 6.3.1
SCHEMATIC-FREQUENCY CONTROL CIRCUIT



NOTES:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS
2. * DENOTES SELECTED VALUE

2A FIGURE 6.3.2
SCHEMATIC-VARIABLE SYMMETRY (A)(B)

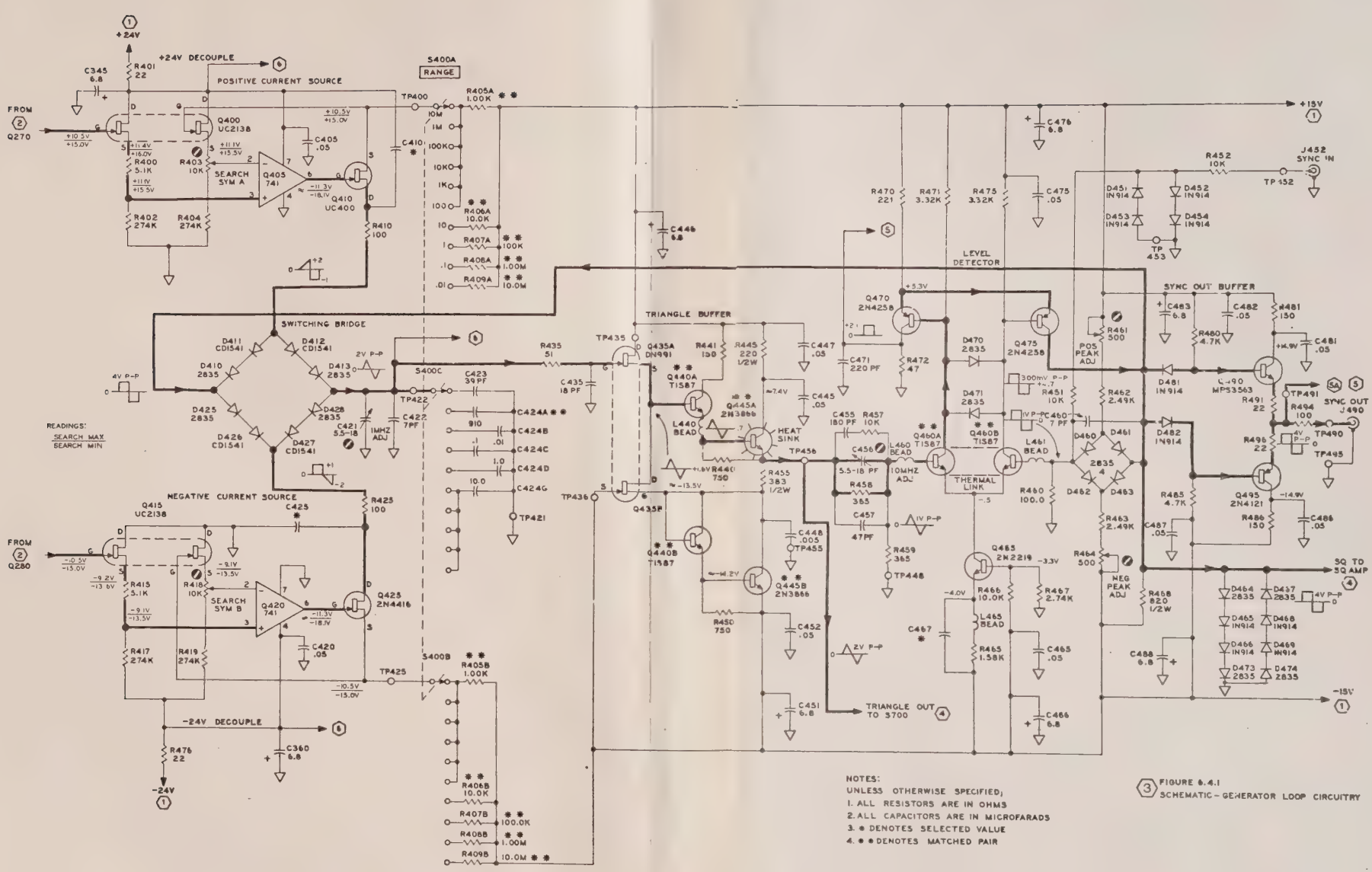


FIGURE 6.4.1
SCHEMATIC - GENERATOR LOOP CIRCUITRY

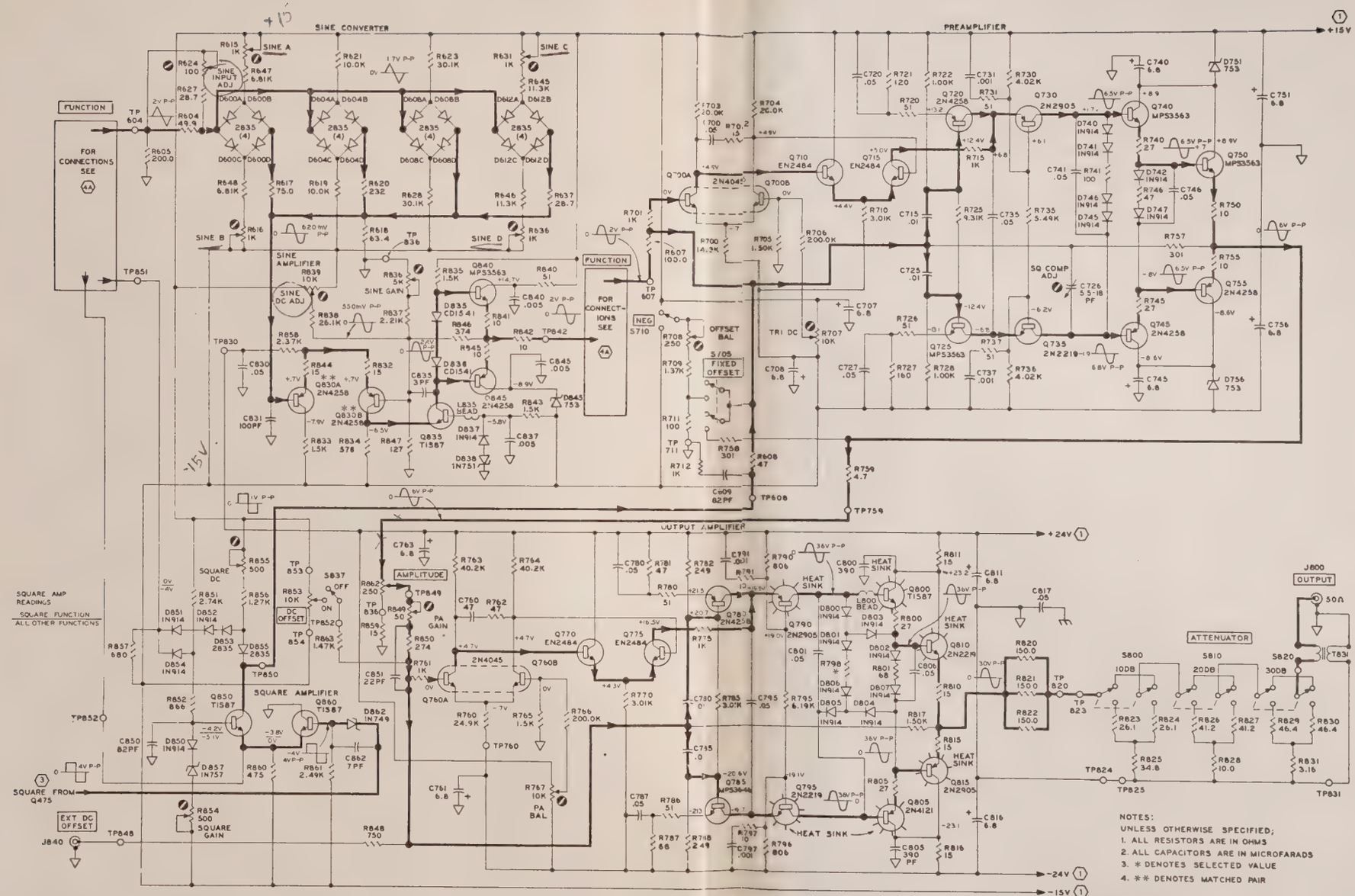
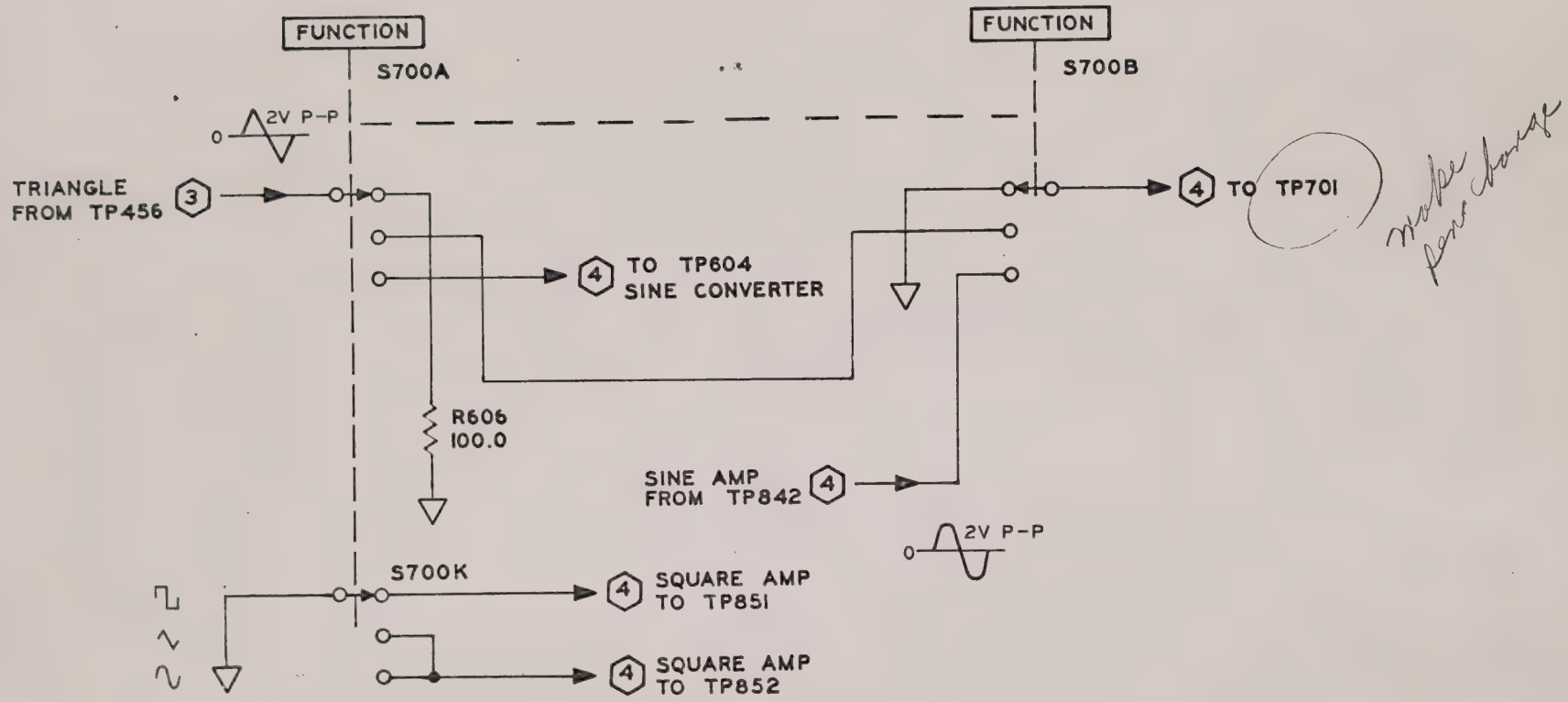


FIGURE 6.5.1
SCHEMATIC - OUTPUT CONDITIONING CIRCUITRY



NOTE:
UNLESS OTHERWISE SPECIFIED;
1. ALL RESISTORS ARE IN OHMS

4A FIGURE 6.5.2
SCHEMATIC-FUNCTION SWITCHING (A)

CONNECTION REFERENCE CHART

ON SCHEMATIC		SCHEMATIC REFFERED TO	CONDITION
(2)	Pin 2, Q240	(5A)	No connection
(2A)	S265B, Normally open contact	(5A)	No connection necessary
(3)	Tp491	(5A)	No other connections this model
(3)	+24V Decouple	(6)	No other connections this model
(3)	-24V Decouple	(6)	No other connections this model
(3)	Tp422	(6)	No other connections this model
(3)	Junction C477 - R472	(6)	No other connections this model

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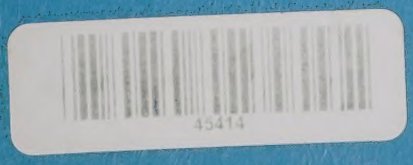
SECTION 7

ADDENDA

At EXACT we continually strive to incorporate latest electronic developments by adding circuit and component improvements to our instrument line as they are developed and tested.

At times, due to printing and shipping requirements, change information is not entered in the main body of the manual. It therefore may contain new change information in the following pages of this section. If change pages do not appear in this section, your manual is correct as printed.


45414